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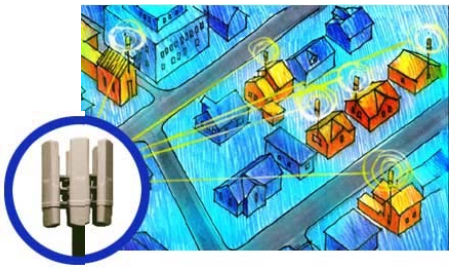

Canopy™ Subscriber Module (SM)

User Manual

SM-UM-en
Issue 5
January 2004

CANOPY™
Motorola Wireless Broadband Platform

NOTICES

Important Note on Modifications

Intentional or unintentional changes or modifications to the equipment must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

U.S. Federal Communication Commision (FCC) and Industry Canada (IC) Notification

This device complies with part 15 of the U. S. FCC Rules and Regulations and with RSS-210 of Industry Canada. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation. In Canada, users should be cautioned to take note that high power radars are allocated as primary users (meaning they have priority) of 5250 – 5350 MHz and 5650 – 5850 MHz and these radars could cause interference and/or damage to license-exempt local area networks (LELAN).

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the U.S. FCC Rules and with RSS-210 of Industry Canada. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to correct the interference by one or more of the following measures:

- Increase the separation between the affected equipment and the unit;
- Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to;
- Consult the dealer and/or experienced radio/TV technician for help.

FCC IDs and Industry Canada Certification Numbers are listed in the following table:

Module Types	Frequency Band Range	Maximum Transmitter Power	Reflector	FCC ID	Industry Canada Cert Number
SM AP BH	ISM 2400-2483.5 MHz	340 mW	Allowed on SM and BH	ABZ89FC5808	109W-2400
SM AP BH	U-NII 5250-5350 MHz	200 mW	Not Allowed	ABZ89FC3789	109W-5200
SM BH	U-NII 5250-5350 MHz	3.2 mW	Recommended	ABZ89FC5807	109W-5210
SM AP BH	U-NII 5725-5825 MHz	200 mW	Allowed on SM and BH	ABZ89FC4816	109W-5700
SM AP BH	ISM 5725-5850 MHz	200 mW	Allowed on SM and BH	ABZ89FC5804	109W-5700

The term "IC:" before the radio certification number only signifies that Industry Canada technical specifications were met.

European Community Notification

Notification of Intended Purpose of Product Uses

This product is a two-way radio transceiver suitable for use in Broadband RLAN systems. It uses operating frequencies which are not harmonized through the EC. All licenses must be obtained before using the product in any EC country.

Declaration of conformity:
Motorola declares the GHz radio types listed below comply with the essential requirements and other relevant provisions of Directive1999/5/EC.

Relevant Specification
EN 301 893 or similar - radio spectrum
EN301489-17 - EMC
EN60950 – safety

CE !

Product Details for Products Tested for Compliance with Relevant EC Directives

Module Type	Frequency Band Range	Maximum Transmitter Power	Effective Isotropic Radiated Power (EIRP)	Modulation Type	Operating Channels	Non-overlapping Channel Spacing
Access Point	5.725 to 5.825 GHz	200 mW RMS	1 Watt EIRP	High Index 2-level FSK	5745 to 5805 MHz in 5-MHz increments	20 MHz
Subscriber Module	5.725 to 5.825 GHz	200 mW RMS	1 Watt EIRP	High Index 2-level FSK	5745 to 5805 MHz in 5-MHz increments	20 MHz
Subscriber Module with Reflector	5.725 to 5.825 GHz	200 mW RMS	63 Watts EIRP	High Index 2-level FSK	5745 to 5805 MHz in 5-MHz increments	20 MHz
Backhaul	5.725 to 5.825 GHz	200 mW RMS	1 Watt EIRP	High Index 2-level or 4-level FSK	5745 to 5805 MHz in 5-MHz increments	20 MHz
Backhaul with Reflector	5.725 to 5.825 GHz	200 mW RMS	63 Watts EIRP	High Index 2-level or 4-level FSK	5745 to 5805 MHz in 5-MHz increments	20 MHz

Canopy can be configured to operate at a range of frequencies, but at this time, only channels from 5745 MHz through 5805 MHz of the 5.7 GHz product have been tested for compliance with relevant EC directives. Before configuring equipment to operate outside this range, please check with your regulator.

Exposure Note

A Canopy module must be installed to provide a separation distance of at least 20 cm (7.9 in) from all persons. When adding the Canopy reflector dish, the reflector dish must be installed to provide a separation distance of at least 1.5m (59.1 in) from all persons. When so installed, the module's RF field is within Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website http://www.hc-sc.gc.ca/rpb.

In both configurations the maximum RMS power does not exceed 340mW.

The applicable power density exposure limit is 10 Watt/m^2, according to the FCC OET Bulletin 65, the ICNIRP guidelines, and the Health Canada Safety Code 6. The corresponding compliance distances referenced above have been determined by assuming worst-case scenarios. The peak power density (*S*) in the far-field of a radio-frequency source with rms transmit power *P* and antenna gain *G* at a distance *d* is

$$S = \frac{P \cdot G}{4\pi d^2}$$

In the case of the Canopy SM *without* reflector, the gain is 8 dBi (a factor of 6.3), so the peak power density equals the exposure limit at a distance of 13 cm for 2.4 GHz product and 10 cm for 5.2 and 5.7 GHz product. A power compliance margin of over 2 is artificially introduced by setting the distance to a consistent 20 cm across all modules, giving a power compliance margin of x2.4 for 2.4 GHz modules and x4 for 5.2 and 5.7 GHz modules.

In the case of the Canopy SM *with* reflector, the gain depends on frequency and ranges from 19 dBi (a factor of 80) for 2.4 GHz modules to 26 dBi (a factor of 400) for 5.2 GHz Extended Range and 5.7 GHz modules, so the peak power density equals the exposure limit at a distance of 10 to 80 cm. A power compliance margin is artificially introduced by defining a consistent compliance distance of 1.5 m across all modules with reflectors, giving a power compliance margin of x10 for 2.4 GHz modules, x220 for 5.2 GHz Extended Range modules, and x3.5 for 5.7 GHz modules. The compliance distance is greatly overestimated in this case because the far-field equation neglects the physical dimension of the antenna, which is modeled as a point-source.

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Motorola U.S. offers a warranty covering a period of one year from the date of purchase by the customer. If a product is found defective during the warranty period, Motorola will repair or replace the product with the same or a similar model, which may be a reconditioned unit, without charge for parts or labor.

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USA

http://www.motorola.com/canopy

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1 WELCOME

Thank you for purchasing Motorola Canopy™ Backhaul Modules. This technology is the latest innovation in high speed wireless networking. Canopy system features include

- network speeds of 10/100 BaseT.
- small compact design.
- no special requirements for PC setup.

1.1 FEEDBACK

We welcome your feedback on Canopy system documentation.[1] This includes feedback on the structure, content, accuracy, or completeness of our documents, and any other comments you have. Please send your comments to technical-documentation@canopywireless.com.

1.2 TECHNICAL SUPPORT

To get information or assistance as soon as possible for problems that you encounter, use the following sequence of action:

1. Search this document, the user manuals that support other modules, and the software release notes of supported releases
   a. in the Table of Contents for the topic.
   b. in the Adobe Reader® search capability for keywords that apply.[2]
2. Visit the Canopy systems website at http://www.canopywireless.com.
3. Ask your Canopy products supplier to help.
4. Gather information such as
   - the IP addresses and MAC addresses of any affected Canopy modules.
   - the software releases that operate on these modules.
   - data from the Event Log page of the modules.
   - the configuration of software features on these modules.
5. Escalate the problem to Canopy systems Technical Support (or another Tier 3 technical support that has been designated for you) as follows. You may either
   - send e-mail to technical-support@canopywireless.com.
   - call 1 888 605 2552 during the following hours of operation:
     Monday through Sunday
     7:00 a.m. to 11:00 p.m. EST

For warranty assistance, contact your reseller or distributor for the process.

[1] Canopy is a trademark of Motorola, Inc.
[2] Reader is a registered trademark of Adobe Systems, Incorporated.

2 ABOUT THIS DOCUMENT

The following information describes the purpose of this document and the reasons for reissue.

2.1 INTENDED USE

This manual includes Canopy features through Software Release 4.1. The audience for this manual comprises system operators, network administrators, and equipment installers. The user of this manual should have

- basic knowledge of RF theory. (See General RF Considerations on Page 48.)
- network experience. (See General IP Addressing Concepts on Page 66.)

2.2 NEW IN THIS ISSUE

This document has been revised to include changes in technical content.

Issue 5 introduces the following changes:

- Rearrangement of topics to make the document easier to return to as a reference source.
- Editorial changes to reduce redundancy and clarify technical concepts.
- Revision of the warranty stated in the legal section above (effective for products purchased on or after October 1, 2003).
- Information that supports 2.4-GHz Canopy modules. See
  - Types of SM Applications on Page 16.
  - Selection of SM Types and Passive Reflectors on Page 47.
  - Channel Plans on Page 58.
  - Table 11 on Page 70.
  - Custom RF Frequency Scan Selection List on Page 87.
  - SM MODULE SPECIFICATIONS on Page 117.
- Reminders to observe local and national regulations.
- Description of the Canopy Bandwidth and Authentication Manager (BAM) and BAM features, which provide bandwidth and security above what an AP without the BAM provides. See Bandwidth and Authentication Manager (BAM) on Page 22.
- Examples of interactions between burst data rate and sustained data rate settings. See Interaction of Burst Data and Sustained Data Settings on Page 23.
- A Configuration page selection in the AP that allows multiple APs to send beacons to multiple SMs in the same range without interference. See Transmit Frame Spreading on Page 26.
- More logical telnet session for branding the interface screens. See Figure 11 on Page 28.
- Procedures to deny or permit remote access to an SM. See Denying All Remote Access on Page 28 and Reinstating Remote Access Capability on Page 29.

- Information on the MIB (Management Information Base) that a network management system can access through SNMP (Simple Network Management Protocol) to monitor and control variables in the Canopy system. See SNMP on Page 29.
- NAT (network address translation) for SMs. See NAT, DHCP Server, DHCP Client, and DMZ in SM on Page 41.
- Links to Canopy System Calculator pages for
  - beam width dimensions (see Vertical Beam Width on Page 48).
  - miminum antenna elevation (see Radio Horizon on Page 49.
  - antenna downward tilt angle (see Antenna Downward Tilt on Page 50).
  - Fresnel zone dimensions (see Fresnel Loss on Page 51).
  - free space path loss (see Free Space Path Loss on Page 53).
- A procedure to use the AP to update the software release of all registered SMs that are entered onto an action list. See AP Update of SM Software Release on Page 56.
- A procedure to use the SM as a spectrum analyzer for site planning and for alignment. See Spectrum Analysis on Page 59.
- A procedure to reduce the power of module transmission to mitigate or avoid interference. See Power Reduction to Mitigate Interference on Page 59.
- Expansion and clarification of available channel frequencies. See Channel Plans on Page 58.
- Corrections for the roles of Pins 4 and 5 (to +V return) and Pins 7 and 8 (to +V). See Connector Wiring on Page 72.
- Clarifications about the use of an override plug to regain control of a module. See Overriding IP Address and Password Setting on Page 73.
- A procedure that allows sync to be passed in one additional link. See Wiring to Extend Network Sync on Page 74.
- A procedure to use the Audible Alignment Tone feature. See Step 11 on Page 78.
- A new field in the Status page to specify the active encryption technology with reboot and software version information. See Canopy Boot Version on Page 83.
- A new field in the Configuration page to activate a feature that disallows the SM to send and receive data through the Ethernet port. See 802.3 Link Enable/Disable on Page 86.
- Clarification of the interactions of password settings. See Display-Only Access on Page 87.
- A new web page for IP configuration. See IP Configuration Page on Page 92.
- A new web page for NAT (network address translation) configuration. See NAT Configuration Page on Page 99.
- A method to suppress AP data from display on the AP Eval Data page of the SM. See AP Eval Data Page on Page 107.
- The part number for ordering the Alignment Tool headset kit. See CANOPY SYSTEM ACCESSORIES on Page 116.
- Clarifications in the module specifications table. See SM MODULE SPECIFICATIONS on Page 117.

See also HISTORY OF CHANGES IN THIS DOCUMENT on Page 119.

2.3 ADDITIONAL FEATURE INFORMATION

Additional information about features that are introduced in new releases is available in Canopy Software Release Notes. These release notes are available at http://www.motorola.com/canopy.

3 SYSTEM OVERVIEW

The Canopy network uses the Canopy components that are defined in Table 1.

Table 1: Definitions of Canopy components

Component	Definition
Access Point Module (AP)	One module that distributes network or Internet services in a 60° sector to 200 subscribers or fewer.
Access Point cluster (AP cluster)	Two to six APs that together distribute network or Internet services to a community of 1,200 or fewer subscribers. Each AP covers a 60° sector. This cluster covers as much as 360°.
Subscriber Module (SM)	A customer premises equipment (CPE) device that extends network or Internet services by communication with an AP or an AP cluster.
Cluster Management Module (CMM)	A module that provides power, GPS timing, and networking connections for an AP cluster. If this CMM is connected to a Backhaul Module (BH), then this CMM is the central point of connectivity for the entire site.
Backhaul Module (BH)	A module that provides point-to-point connectivity as either a standalone link or a link to an AP cluster through a selected AP.

3.1 MODULE-TO-MODULE COMMUNICATIONS

Each SM communicates with an AP in an assigned time slot that the AP controls. The AP coordinates the needs of SMs for data in both the downlink and the uplink to provide seamless communication across the entire network. The BH communicates with another BH, a collocated connection to the network, and a collocated AP.

The AP uses a point-to-multipoint protocol to communicate with each registered SM. The BH timing master uses a point-to-point protocol to communicate with a BH timing slave.

For more information about the AP, see ***Canopy*** *Access Point Module (AP) User Manual*. For more information about the BH, see ***Canopy*** *Backhaul Module (BH) User Manual*.

3.2 TYPES OF SM APPLICATIONS

Subscriber modules are available in 2.4-GHz, 5.2-GHz, and 5.7-GHz frequency bands. Due to regulatory agency restrictions, a 5.2-GHz SM *cannot* be used with a reflector in the U.S.A. or Canada.

A 2.4-GHz or 5.7-GHz SM can be used with a Canopy Passive Reflector dish. This reflector extends the maximum span of a link as defined in Table 2.

Table 2: Range of links with and without Passive Reflector

Module in Link	Reflector	Typical Range[3]
2400SM (DES) with 2400AP (DES)	none	5 miles (8 km)
2401SM (AES) with 2401AP (AES)		
2400SMRF (DES) with 2400AP (DES)	on SM	15 miles (24 km)
2401SMRF (AES) with 2401AP (AES)	on SM	15 miles (24 km)
5200SM (DES)[1] with 5200AP (DES)	None allowed in U.S.A or Canada	2 miles (3.2 km)
5201SM (AES)[2] with 5201AP (AES)		
5700SM (DES) with 5700AP (DES)	none	2 miles (3.2 km)
5701SM (AES) with 5701AP (AES)		
5700SMRF (DES) with 5700AP (DES)	on SM	10 miles (16 km)
5701SMRF (AES) with 5701AP (AES)	on SM	10 miles (16 km)

NOTES:

1. DES indicates that the module is preconfigured for Data Encryption Standard security. See DES Encryption on Page 21.
2. AES indicates that the module is preconfigured for Advanced Encryption Standard security. See AES Encryption on Page 21.
3. Terrain and other line of sight circumstances affect the distance that can be achieved. Additionally, local or national radio regulations may govern whether and how the Passive Reflector can be deployed.

3.3 SYNCHRONIZATION

The CMM is a critical element in the operation of the Canopy system. At one AP cluster site or throughout an entire wireless system, the CMM provides a GPS timing pulse to each module, synchronizing the network transmission cycles.

3.3.1 Unsynchronized Modules

Without this pulse, an AP is unsynchronized, and a BH timing master cannot synchronize a BH timing slave. An unsynchronized module may transmit during a receive cycle of other modules. This can cause one or more modules to receive an undesired signal that is strong enough to make the module insensitive to the desired signal (become desensed).

3.3.2 Passing Sync

In releases earlier than Release 4.0, network sync can be delivered in only one over the air link in any of the following network designs:

- Design 1
  1. A CMM provides sync in Ethernet protocol to a collocated AP.
  2. This AP sends the sync in multipoint protocol over the air to SMs.
- Design 2
  1. A CMM provides sync in Ethernet protocol to a collocated BH timing master.
  2. This BH timing master sends the sync in point-to-point protocol over the air to a BH timing slave.

In Release 4.0 and later releases, network sync can be either delivered as described above or extended by one additional link in any of the following network designs:

NOTE: In each of these following designs, Link 2 *is not* on the same frequency band as Link 4. (For example, Link 2 may be a 5.2-GHz link while Link 4 is a 5.7- or 2.4-GHz link.)

- Design 3
  1. A CMM provides sync in Ethernet protocol to a collocated AP.
  2. This AP sends the sync in multipoint protocol over the air to an SM.
  3. This SM delivers the sync in Ethernet protocol to a collocated AP.
  4. This AP passes the sync in multipoint protocol in the additional link over the air to SMs.

  This design in illustrated in Figure 1.

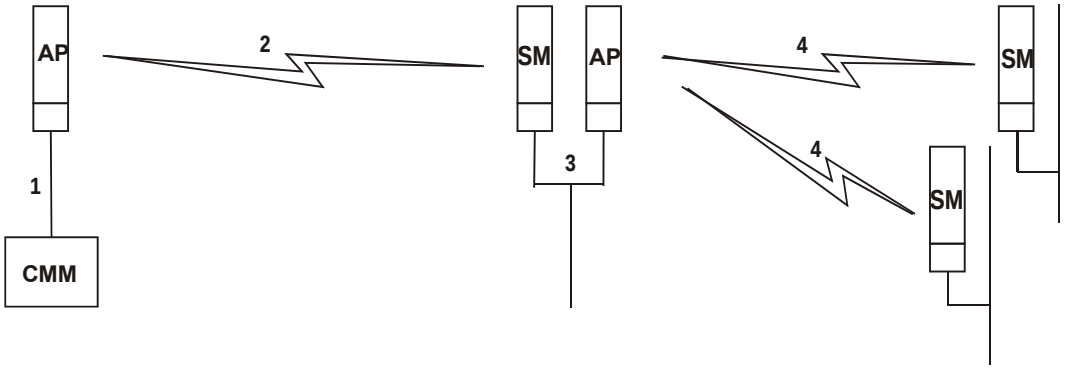


Figure 1: Additional link to extend network sync, Design 3

- Design 4
  1. A CMM provides sync in Ethernet protocol to a collocated AP.
  2. This AP sends the sync in multipoint protocol over the air to an SM.
  3. This SM delivers the sync in Ethernet protocol to a collocated BH timing master.
  4. This BH timing master passes the sync in point-to-point protocol in the additional link over the air to a BH timing slave.

  This design is illustrated in Figure 2.

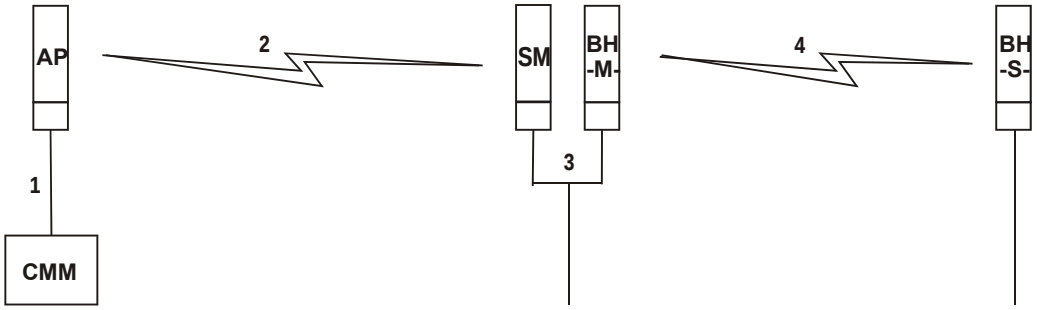


Figure 2: Additional link to extend network sync, Design 4

- Design 5
  1. A CMM provides sync in Ethernet protocol to a collocated BH timing master.
  2. This BH timing master sends the sync in point-to-point protocol over the air to a BH timing slave.
  3. This BH timing slave delivers the sync in Ethernet protocol to a collocated AP.
  4. This AP passes the sync in multipoint protocol in the additional link over the air to SMs.

  This design is illustrated in Figure 3.

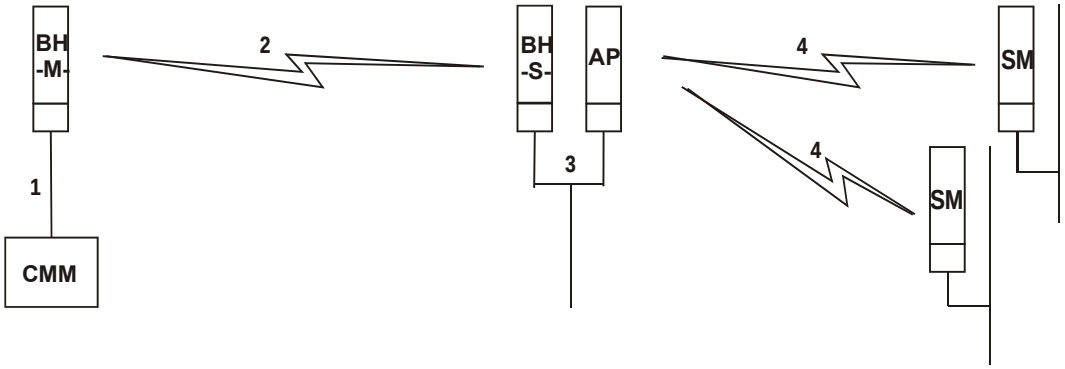
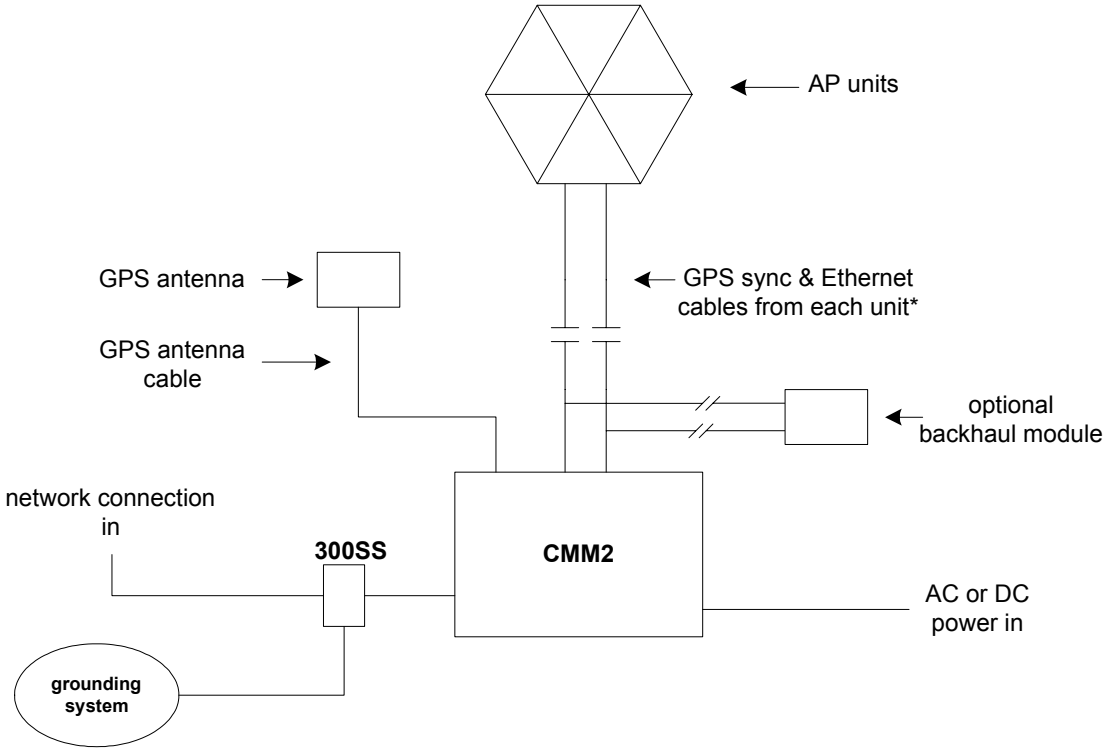


Figure 3: Additional link to extend network sync, Design 5

Wiring and configuration information for this sync extension is described under Wiring to Extend Network Sync on Page 74.

3.4 WIRING

The wiring scheme of the Canopy system is displayed in Figure 4.



* Two cables, Ethernet and GPS sync, connect *each* sector AP to the CMM2.

Figure 4: Canopy system wiring

The wiring scheme of the SM and computer is displayed in Figure 30 on Page 77.

4 ADVANCED FEATURES

The following features are available in the Canopy system but not required for basic operation.

4.1 SECURITY FEATURES

Canopy systems employ the following forms of encryption for security of the wireless link:

- BRAID–a security scheme that the cellular industry uses to authenticate wireless devices.
- DES–Data Encryption Standard, an over-the-air link option that uses secret 56-bit keys and 8 parity bits.
- AES–Advanced Encryption Standard, an extra-cost over-the-air link option that provides extremely secure wireless connections. AES uses 128-bit secret keys as directed by the government of the U.S.A. AES is not exportable and requires a special AP to process the large keys.

4.1.1 BRAID

BRAID is a stream cipher that the TIA (Telecommunications Industry Association) has standardized. Standard Canopy APs and SMs use BRAID encryption to

- calculate the per-session encryption key (independently) on each end of a link.
- provide the digital signature for authentication challenges.

4.1.2 DES Encryption

Standard Canopy modules provide DES encryption. DES performs a series of bit permutations, substitutions, and recombination operations on blocks of data. DES Encryption does not affect the performance or throughput of the system.

4.1.3 AES Encryption

Motorola also offers Canopy products that provide AES encryption. AES uses the Rijndael algorithm and 128-bit keys to establish a higher level of security than DES. Because of this higher level of security, the government of the U.S.A. controls the export of communications products that use AES to ensure that these products are available in only certain regions. The Canopy distributor or reseller can advise service providers about current regional availability.

4.1.4 AES-DES Operability Comparisons

This section describes the similarities and differences between DES and AES products, and the extent to which they may interoperate.

Key Consistency

The DES AP and the DES Backhaul timing master module are factory-programmed to enable or disable *DES* encryption. Similarly, the AES AP and the AES Backhaul timing master module are factory-programmed to enable or disable *AES* encryption.

In either case, the authentication key entered in the SM Configuration page establishes the encryption key. For this reason, the authentication key must be the same on the SM as on the AP.

Feature Availability

Canopy AES products operate on the same software as DES products. Thus feature availability and functionality are and will continue to be the same, regardless of whether AES encryption is enabled. All interface screens are identical. However, when encryption is enabled on the Configuration screen

- the AES product provides AES encryption.
- the DES product provides DES encryption.

Field-programmable Gate Array

Canopy AES products and DES products use different FPGA (field-programmable gate array) loads. However, the AES FPGA will be upgraded as needed to provide new features or services similar to those available for DES products.

Signaling Rates for Backhaul Modules

DES BHs are available in both 10-Mbps and 20-Mbps signaling rates. AES BHs are available with only a 10-Mbps signaling rate.

Upgradeability

Canopy DES products cannot be upgraded to AES. To have the option of AES encryption, the network planner must purchase AES products.

Interoperability

Canopy AES products and DES products do not interoperate when enabled for encryption. For example, An AES AP with encryption enabled cannot communicate with DES SMs. Similarly, an AES BH timing master with encryption enabled cannot communicate with a DES BH timing slave.

However, if encryption is disabled, AES modules can communicate with DES modules.

4.2 BANDWIDTH MANAGEMENT

Each AP controls SM bandwidth management. All SMs registered to an AP receive and use the same bandwidth management information that is set in the AP where they are registered.

The Canopy software uses *token buckets* to manage the bandwidth of each SM. Each SM employs two buckets: one for uplink and one for downlink throughput. These buckets are continuously being filled with tokens at a rate set by the **Sustained Data Rate** variable field in the AP.

4.2.1 Bandwidth and Authentication Manager (BAM)

Canopy offers the Bandwidth and Authentication Manager (BAM) to manage bandwidth *individually* for each SM registered to an AP. BAM allows the setting of Sustained Uplink Data Rate, Sustained Downlink Data Rate, Uplink Burst Allocation, and Downlink Burst Allocation for the individual SM.

BAM also provides secure SM authentication and user-specified DES encryption keys. BAM is an optional Canopy software product that operates on a networked PC.

4.2.2 Recharging Buckets

The **Burst Allocation** variable field in the AP sets the size of each bucket. This limits the maximum number of tokens that can fill a bucket.

If the SM transfers data at the Sustained Data Rate, then the bucket refills at the same rate, and burst is impossible. If the SM transfers data at a rate less than the Sustained Data Rate, then the bucket continues to fill with unused tokens. In this case, required bursting occurs at the rate determined by the number of unused tokens.

After a burst is completed, the bucket is recharged at the Sustained Data Rate. Short bursts recharge faster than large bursts.

4.2.3 Subscriber Module Perspective

Normal web browsing, e-mail, small file transfers, and short streaming video are rarely rate limited, depending on the bandwidth management settings in the AP or the BAM server. When the SM processes large downloads such as software upgrades and long streaming video, or a series of medium-size downloads, these transfer at a bandwidth higher than the Sustained Date Rate (unless no unused tokens remain in the bucket) until the burst limit is reached.

When the burst limit is reached, the data rate falls to the Sustained Data Rate setting. Then later, when the SM is either idle or transferring data at a rate slower than Sustained Data Rate, the burst limit recharges at the Sustained Data Rate.

4.2.4 Interaction of Burst Data and Sustained Data Settings

A Burst Allocation setting

- less than the Sustained Data Rate yields a Sustained Data Rate equal to the Burst Allocation. (See Figure 5 and Figure 7.)
- equal to the Sustained Data Rate negates the burst capability. (See Figure 6.)
- at zero shuts off the data pipe. (See Figure 8.)

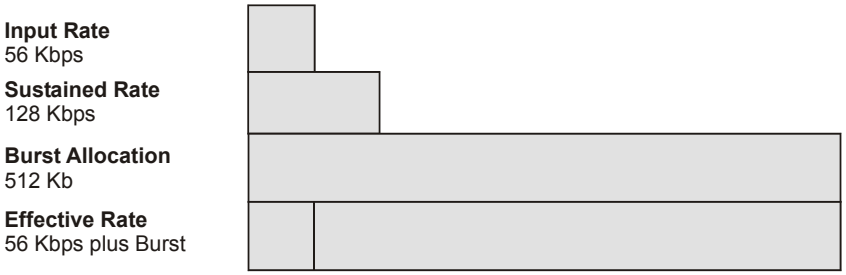


Figure 5: Burst Allocation vs. Sustained Rate, Example 1

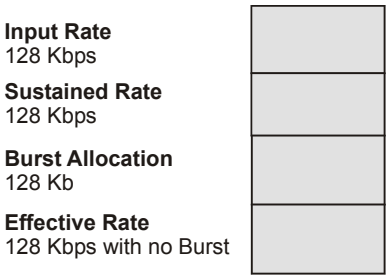


Figure 6: Burst Allocation vs. Sustained Rate, Example 2

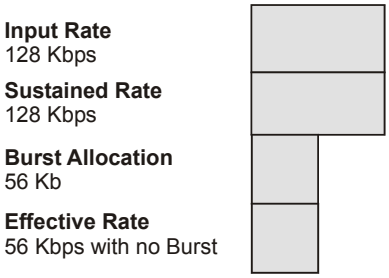


Figure 7: Burst Allocation vs. Sustained Rate, Example 3

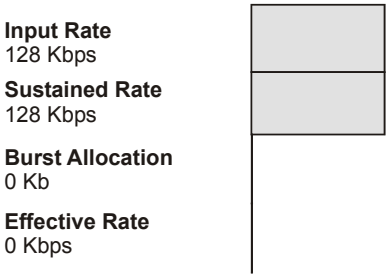


Figure 8: Burst Allocation vs. Sustained Rate, Example 4

4.3 HIGH-PRIORITY BANDWIDTH

To support low-latency traffic such as VoIP (Voice over IP), the Canopy system implements a high-priority channel. This channel does not affect the inherent latencies in the Canopy system but allows high-priority traffic to be immediately served. The high-priority pipe separates low-latency trafiic from traffic that is latency tolerant, such as standard web traffic and file downloads.

The Canopy system separates this traffic by recognizing the IPv4 Type of Service Low Latency bit (Bit 3). Bit 3 is set by a device outside the Canopy system. If this bit is set, the system sends the packet on the high-priority channel and services this channel before any normal traffic.

NOTE: To enable the high-priority channel, the operator must configure *all* high-priority parameters.

The high-priority channel is enabled by configuration of four parameters in the Configuration web page. These parameters are:

- **High Priority Uplink Percentage**
- **UAcks Reserved High**
- **DAcks Reserved High**
- **NumCtrlSlots Reserved High**

4.3.1 High Priority Uplink Percentage

The **High Priority Uplink Percentage** parameter defines the percentage of the uplink bandwidth to dedicate to low-latency traffic. When set, this percentage of RF link bandwidth is permanently allocated to low-latency traffic, regardless of whether low-latency traffic is present. The system provides no corresponding downlink parameter because scheduling algorithms in the AP allocate this bandwidth as needed.

4.3.2 UAcks Reserved High

The **UAcks Reserved High** parameter defines the number of uplink slots used to acknowledge high-priority data that is received by an SM. The recommended setting for this parameter is 3. The recommended setting for the corresponding **TotalNumUAcksSlots** parameter is 6.

4.3.3 DAcks Reserved High

The **DAcks Reserved High** parameter defines the number of downlink slots used to acknowledge high-priority data that is received by an AP. The recommended setting for this parameter is 3. The recommended setting for the corresponding **NumDAckSlots** parameter is 6.

4.3.4 NumCtrlSlots Reserved High

The **NumCtrlSlots Reserved High** parameter defines the number of slots used to send control messages to an AP. The recommended setting for this parameter is 3. The recommended setting for the corresponding **NumCtlSlots** parameter is 6.

4.3.5 Allocations to Downlink and Uplink

Figure 9 illustrates the format of the high-priority channel.

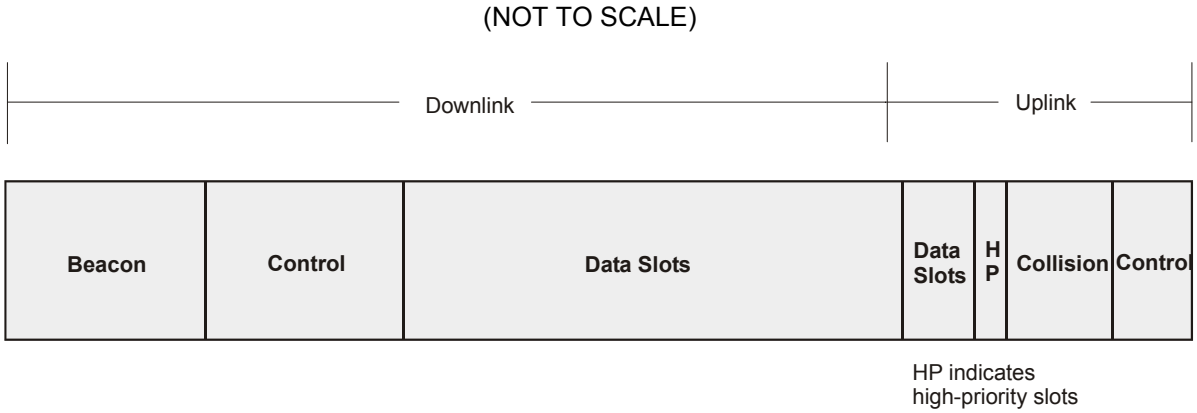


Figure 9: High-priority channel layout

Example Allocation

At AP default downlink-to-uplink settings (75% downlink and 25% uplink), if High Priority is set to 25%, then

- in the uplink, the total of reserved slots is equivalent to 25%, 2 slots in this example:
  - The bandwidth is 64 bytes per slot, repeated 400 times each second.
  - [2 slots/instance] x [64 bytes/slot] x [8 bits/byte] x [400 instances/second] = 409,600 bps

    ≈ 400 kbps of uplink bandwidth
- in the downlink, the AP
  - does not reserve slots, but will service all high-priority bandwidth requests.
  - may become saturated by attempting to service too much high-priority traffic.
  - monitors the Low Latency TOS (Type of Service) bit, Bit 3, in the Ethernet frame.
  - prioritizes the traffic in the high-priority queue (when Bit 3 is set) according to the AP configuration settings for the high-priority channel.

4.3.6 Transmit Frame Spreading

If the operator selects the Transmit Frame Spreading option in the Configuration page of the AP, SMs between two APs can register in the assigned AP (not the other AP). If all SMs operate on Release 4.0 or later, then selection of this option is strongly recommended.

With this selection, the AP does not transmit a beacon in each frame, but rather transmits a beacon in only pseudo-random frames in which the SM expects the beacon. This allows multiple APs to send beacons to multiple SMs in the same range without interference.

However, if Transmit Frame Spreading is selected in a Release 4.0 AP, and this AP transmits to an SM that operates on an earlier release, the SM expects more frequent beacons and may lose sync and eventually lose registration. To avoid this, all SMs that register to an AP that has Transmit Frame Spreading selected should operate on Release 4.0 or a later release.

4.4 BRANDING

The web-based interface screens on each Canopy module contain the Canopy logo. This logo can be replaced with a custom company logo. A file named `canopy.jpg` generates the Canopy logo.

Procedure 1: Replacing the Canopy logo

You can replace the Canopy logo as follows:

1. Copy your custom logo file to the name `canopy.jpg` on your system.
2. Use an FTP (File Transfer Protocol) session to transfer the new `canopy.jpg` file to the module, as in the example session shown in Figure 10.

```
> ftp 169.254.1.1
Connected to 169.254.1.1
220 FTP server ready
Name (169.254.1.1:none): root
331 Guest login ok
Password: <password-if-configured>
230 Guest login ok, access restrictions apply.

ftp> binary
200 Type set to I
ftp> put canopy.jpg
ftp> quit
221 Goodbye
```

Figure 10: Example FTP session

3. Use a `telnet` session to add the new `canopy.jpg` file to the file system, as in the example session shown in Figure 11.

   NOTE: Available `telnet` commands execute the following results:

   - **`addwebfile`** adds a custom logo file to the file system.
   - **`clearwebfile`** clears the customer logo file from the file system.
   - **`lsweb`** lists the custom logo file and display the storage space available on the file system.

```
/---------\
C A N O P Y

Motorola Broadband Wireless Technology Center
(Copyright 2001, 2002 Motorola Inc.)

Login: root
Password: <password-if-configured>

Telnet+> lsweb

Flash Web files
/canopy.jpg     7867
free directory entries: 31
free file space: 56468

Telnet +> clearwebfile
Telnet+> lsweb

Flash Web files
free directory entries: 32
free file space     64336 bytes

Telnet+> addwebfile canopy.jpg
Telnet +> lsweb

Flash Web files
/canopy.jpg     7867
free directory entries: 31
free file space: 55331

Telnet +> exit
```

Figure 11: Example telnet session to change screen logo

4.5 DENYING ALL REMOTE ACCESS

For a network where additional security is more important that ease of network administration, all remote access to an AP can be disabled as follows:

Procedure 2: Denying all remote access

1. Insert the override plug into the RJ-11 GPS sync port of the AP.
2. Power up or power cycle the AP.
3. Access the web page http://169.254.1.1/lockconfig.html.
4. Click the check box.
5. Save the changes.
6. Reboot the AP.
7. Remove the override plug.

RESULT: No access to this AP is possible through HTTP, SNMP, FTP, telnet, or over an RF link.

4.6 REINSTATING REMOTE ACCESS CAPABILITY

Where ease of network administration is more important than the additional security that the No Remote Access feature provides, this feature can be disabled as follows:

Procedure 3: Reinstating remote access capability

1. Insert the override plug into the RJ-11 GPS sync port of the AP.
2. Power up or power cycle the AP.
3. Access the web page http://169.254.1.1/lockconfig.html.
4. Click the check box to uncheck the field.
5. Save the changes.
6. Reboot the AP.
7. Remove the override plug.

RESULT: Access to this AP is possible through HTTP, SNMP, FTP, telnet, or over an RF link.

4.7 SNMP

SNMPv2 (Simple Network Management Protocol Version 2) can be used to manage and monitor the Canopy modules under SMI (Structure of Management Information) specifications. SMI specifies management information definitions in ASN.1 (Abstract Syntax Notation One) language. SNMPv2 supports both 32-bit and 64-bit counters. The SMI for SNMPv2 is defined in RFC 1902 at http://www.faqs.org/rfcs/rfc1902.html.

4.7.1 Agent

In SNMP, software on each managed device acts as the *agent*. The agent collects and stores management information in ASN.1 format, in a structure that a MIB (management information base) defines. The agent responds to commands to

- send information about the managed device.
- modify specific data on the managed device.

4.7.2 Managed Device

In SNMP, the managed device is the network element that operates on the agent software. In the Canopy network, this managed device is the module (AP, SM, or BH). With the agent software, the managed device has the role of server in the context of network management.

4.7.3 NMS

In SNMP, the NMS (network management station) has the role of client. An application (manager software) operates on the NMS to manage and monitor the modules in the network through interface with the agents.

4.7.4 Dual Roles

The NMS can simultaneously act as an agent. In such an implementation, the NMS acts as

- client to the agents in the modules, when polling for the agents for information and sending modification data to the agents.
- server to another NMS. when being polled for information gathered from the agents and receiving modification data to send to the agents.

4.7.5 SNMP Commands

To manage a module, SNMPv2 supports the `set` command, which instructs the agent to change the data that manages the module.

To monitor a network element (Canopy module), SNMPv2 supports

- the `get` command, which instructs the agent to send information about the module to the manager in the NMS.
- traversal operations, which the manager uses to identify supported objects and to format information about those objects into relational tables.

In a typical Canopy network, the manager issues these commands to the agents of more than one module (to all SMs in the operator network, for example).

4.7.6 Traps

When a specified event occurs in the module, the agent initiates a trap, for which the agent sends an unsolicited asynchronous message to the manager.

4.7.7 MIBS

The MIB, the SNMP-defined data structure, is a tree of standard branches that lead to optional, non-standard positions in the data hierarchy. The MIB contains both

- objects that SNMP is allowed to control (bandwidth allocation or access, for example)
- objects that SNMP is allowed to monitor (packet transfer, bit rate, and error data, for example).

The path to each object in the MIB is unique to the object. The endpoint of the path is the object identifier.

Paths

The standard MIB hierarchy includes the following cascading branch structures:

- the top (standard body) level:
  - ccitt (0)
  - **iso (1)**
  - iso-ccitt (2)
- under iso (1) above:
  - standard (0)
  - registration-authority (1)
  - member-body (2)
  - **identified-organization (3)**
- under identified-organization (3) above:
  - **dod (6)**
  - other branches
- under dod (6) above:
  - **internet (1)**
  - other branches
- under internet (1) above:
  - **mgmt (2)**
  - **private (4)**
  - other branches
- under mgmt (2) above: **mib-2 (1)** and other branches. (See MIB-II below.)

  under private (4) above: **enterprise (1)** and other branches. (See Canopy Enterprise MIB below.)

  Beneath this level are non-standard branches that the enterprise may define.

Thus, the path to an object that is managed under MIB-II begins with the decimal string **1.3.6.1.2.1** and ends with the object identifier and instance(s), and the path to an object that is managed under the Canopy Enterprise MIB begins with **1.3.6.1.4.1**, and ends with the object identifier and instance(s).

Objects

An object in the MIB can have either only a single instance or multiple instances, as follows:

- a scalar object has only a single instance. A reference to this instance is designated by `.0`, following the object identifier.
- a tabular object has multiple instances that are related to each other. Tables in the MIB associate these instances. References to these instances typically are designated by `.1`, `.2`, and so forth, following the object identifier.

4.7.8 MIB-II

The standard MIB-II (Management Information Base systems and interface) objects are programmed into the Canopy modules. To read this MIB, see *Management Information Base for Network Management of TCP/IP-based Internets: MIB II*, RFC 1213 at http://www.faqs.org/rfcs/rfc1213.html.

The MIB-II standard categorizes each object as one of the types defined in Table 3:

Table 3: Categories of MIB-II objects

Objects in category…	Control or identify the status of…
system	system operations in the module.
interfaces	the network interfaces for which the module is configured.
ip	Internet Protocol information in the module.
icmp	Internet Control Message Protocol information in the module. (These messages flag IP problems and allow IP links to be tested.)
tcp	Transport Control Protocol information in the module (to control and ensure the flow of data on the Internet).
udp	User Datagram Protocol information in the module (for checksum and address).

4.7.9 Canopy Enterprise MIB

For additional reporting and control, the Canopy Releases 3.2.5 and later provide the Canopy Enterprise MIB, which extends the objects for any NMS that uses SNMP interaction. This MIB comprises five text files that are formatted in standard ASN.1 (Abstract Syntax Notation One) language.

Procedure 4: Installing the Canopy Enterprise MIB files

To use this MIB, perform the following steps:

1. On the NMS, immediately beneath the `root` directory, create directory *`mibviewer`*.
2. Immediately beneath the *`mibviewer`* directory, create directory *`canopymibs`*.
3. Download the following three standard MIB files from http://www.simpleweb.org/ietf/mibs into the *`mibviewer/canopymibs`* directory on the NMS:
   - SNMPv2-SMI.txt, which defines the Structure of Management Information specifications.
   - SNMPv2-CONF.txt, which allows macros to be defined for object group, notification group, module compliance, and agent capabilities.
   - SNMPv2-TC.txt, which defines general textual conventions.

4. Move the following five files from your Canopy software package directory into the *mibviewer/canopymibs* directory on the NMS (if necessary, first download the software package from http://www.motorola.com/canopy):

   - `whisp-tcv2-mib.txt` (Textual Conventions MIB), which defines Canopy system-specific textual conventions
   - `WHISP-GLOBAL-REG-MIB.txt` (Registrations MIB), which defines registrations for global items such as product identities and product components.
   - `WHISP-BOX-MIBV2-MIB.txt` (Box MIB), which defines module-level (AP, SM, and BH) objects.
   - `WHISP-APS-MIB.txt` (APs MIB), which defines objects that are specific to the AP or BH timing master.
   - `WHISP-SM-MIB.txt` (SM MIB), which defines objects that are specific to the SM or BH timing slave.
   - `CMM3-MIB.txt` (CMM3 MIB), which defines objects that are specific to the CMMmicro.

   NOTE: The operator should not edit these MIB files in ASN.1. These files are intended for manipulation by only the NMS. However, the operator can view these files through a commercially available MIB viewer.

5. Download a selected MIB viewer into directory *mibviewer*.
6. As instructed by the user documentation that supports your NMS, import the eight MIB files that are listed above.

4.7.10 Module Parameters for SNMP Implementation

Canopy modules provide the following Configuration web page parameters that govern SNMP access from the manager to the agent:

- **Display-Only Access**, which specifies the password that allows only viewing.
- **Full Access**, which specifies the password that allows both viewing and changing.
- **Community String**, which specifies the password for security between managers and the agent.
- **Accessing Subnet**, which specifies the subnet mask allows managers to poll the agents.
- **Trap Address**, which specifies the IP address of the NMS.

For more information about each of these fields, see the user document that supports the module.

4.7.11 Objects Defined in the Canopy Enterprise MIB

The Canopy Enterprise MIB defines objects for

- APs and BH timing masters
- SMs and BH timing slaves
- CMMmicros

AP, SM, and BH Objects

The objects that the Canopy Enterprise MIB defines for each AP and BH Timing Master are listed in Table 4.

Table 4: Canopy Enterprise MIB objects for APs, SMs, and BHs

Object Name	Value Syntax	Operation Allowed
bhModulation	Integer	manage and/or monitor
bhTimingMode	Integer	manage and/or monitor
boxTemperature	DisplayString	monitor
bridgeEntryTimeout	Integer	manage and/or monitor
clearEventLog	Integer	manage and/or monitor
colorCode	Integer	manage and/or monitor
displayOnlyAccess	DisplayString	manage and/or monitor
fullAccess	DisplayString	manage and/or monitor
linkNegoSpeed	DisplayString	manage and/or monitor
pass1Status	DisplayString	monitor
pass2Status	DisplayString	monitor
reboot	Integer	manage and/or monitor
snmpMibPerm	Integer	manage and/or monitor
webAutoUpdate	Integer	manage and/or monitor
whispBoxBoot	DisplayString	monitor
whispBoxEsn	WhispMACAddress	monitor
whispBoxEvntLog	EventString	monitor
whispBoxFPGAVer	DisplayString	monitor
whispBoxSoftwareVer	DisplayString	monitor
whispBridgeAge	Integer	monitor
whispBridgeDesLuid	WhispLUID	monitor
whispBridgeExt	Integer	monitor
whispBridgeHash	Integer	monitor
whispBridgeMacAddr	MacAddress	monitor
whispBridgeTbErr	Integer	monitor

Object Name	Value Syntax	Operation Allowed
whispBridgeTbFree	Integer	monitor
whispBridgeTbUsed	Integer	monitor

AP and BH Timing Master Objects

The objects that the Canopy Enterprise MIB defines for each AP and BH Timing Master are listed in Table 5. The highlighted objects are commonly monitored by the manager. The traps provided in this set of objects are listed under Traps Provided in the Canopy Enterprise MIB on Page 40.

Table 5: Canopy Enterprise MIB objects for APs and BH timing masters

Object Name	Value Syntax	Operation Allowed
actDwnFragCount	Gauge32	monitor
actDwnLinkIndex	Integer	monitor
actUpFragCount	Gauge32	monitor
apBeaconInfo	Integer	manage and/or monitor
asIP1	IpAddress	manage and/or monitor
asIP2	IpAddress	manage and/or monitor
asIP3	IpAddress	manage and/or monitor
authKey	DisplayString	manage and/or monitor
authMode	Integer	manage and/or monitor
berMode	Integer	manage and/or monitor
dAcksReservHigh	Integer	manage and/or monitor
dataSlotDwn	Integer	monitor
dataSlotUp	Integer	monitor
dataSlotUpHi	Integer	monitor
defaultGw	IpAddress	manage and/or monitor
downLinkEff	Integer	monitor
downLinkRate	Integer	monitor
dwnLnkAckSlot	Integer	monitor
dwnLnkAckSlotHi	Integer	monitor
dwnLnkData	Integer	manage and/or monitor

Object Name	Value Syntax	Operation Allowed
dwnLnkDataRate	Integer	manage and/or monitor
dwnLnkLimit	Integer	manage and/or monitor
encryptionMode	Integer	manage and/or monitor
expDwnFragCount	Gauge32	monitor
expUpFragCount	Gauge32	monitor
fpgaVersion	DisplayString	monitor
gpsInput	Integer	manage and/or monitor
gpsStatus	DisplayString	monitor
gpsTrap	Integer	manage and/or monitor
highPriorityUpLnkPct	Integer	manage and/or monitor
lanIp	IpAddress	manage and/or monitor
lanMask	IpAddress	manage and/or monitor
linkAirDelay	Integer	monitor
linkAveJitter	Integer	monitor
linkDescr	DisplayString	monitor
linkESN	PhysAddress	monitor
linkInDiscards	Counter32	monitor
linkInError	Counter32	monitor
linkInNUcastPkts	Counter32	monitor
linkInOctets	Counter32	monitor
linkInUcastPkts	Counter32	monitor
linkInUnknownProtos	Counter32	monitor
linkLastJitter	Integer	monitor
linkLastRSSI	Integer	monitor
linkLUID	Integer	monitor
linkMtu	Integer	monitor
linkOutDiscards	Counter32	monitor
linkOutError	Counter32	monitor
linkOutNUcastPkts	Counter32	monitor

Object Name	Value Syntax	Operation Allowed
linkOutOctets	Counter32	monitor
linkOutQLen	Gauge32	monitor
linkOutUcastPkts	Counter32	monitor
linkRegCount	Integer	monitor
linkReRegCount	Integer	monitor
linkRSSI	Integer	monitor
linkSessState	Integer	monitor
linkSpeed	Gauge32	monitor
linkTestAction	Integer	manage and/or monitor
linkTestDuration	Integer	manage and/or monitor
linkTestError	DisplayString	monitor
linkTestLUID	Integer	manage and/or monitor
linkTestStatus	DisplayString	monitor
linkTimeOut	Integer	monitor
maxDwnLinkIndex	Integer	monitor
maxRange	Integer	manage and/or monitor
numCtlSlots	Integer	manage and/or monitor
numCtlSlotsReserveHigh	Integer	manage and/or monitor
numCtrSlot	Integer	monitor
numCtrSlotHi	Integer	monitor
numDAckSlots	Integer	manage and/or monitor
numUAckSlots	Integer	manage and/or monitor
PhysAddress	PhysAddress	monitor
privateIp	IpAddress	manage and/or monitor
radioSlicing	Integer	monitor
radioTxGain	Integer	monitor
regCount	Integer	monitor
regTrap	Integer	manage and/or monitor
rfFreqCarrier	Integer	manage and/or monitor

Object Name	Value Syntax	Operation Allowed
sectorID	Integer	manage and/or monitor
sessionCount	Integer	monitor
softwareBootVersion	DisplayString	monitor
softwareVersion	DisplayString	monitor
testDuration	Integer	monitor
testLUID	Integer	monitor
txSpreading	Integer	manage and/or monitor
uAcksReservHigh	Integer	manage and/or monitor
upLinkEff	Integer	monitor
upLinkRate	Integer	monitor
upLnkAckSlot	Integer	monitor
upLnkAckSlotHi	Integer	monitor
upLnkDataRate	Integer	manage and/or monitor
upLnkLimit	Integer	manage and/or monitor
whispGPSStats	Integer	monitor

SM and BH Timing Slave Objects

The objects that the Canopy Enterprise MIB defines for each SM and BH Timing Slave are listed in Table 6. The highlighted objects are commonly monitored by the manager.

Table 6: Canopy Enterprise MIB objects for SMs and BH timing slaves

Object Name	Value Syntax	Operation Allowed
airDelay	Integer	monitor
alternateDNSIP	IpAddress	manage and/or monitor
arpCacheTimeout	Integer	manage and/or monitor
authKey	DisplayString	manage and/or monitor
authKeyOption	Integer	manage and/or monitor
calibrationStatus	DisplayString	monitor
defaultGw	IpAddress	manage and/or monitor
dhcpcdns1	IpAddress	monitor

Object Name	Value Syntax	Operation Allowed
dhcpcdns2	IpAddress	monitor
dhcpcdns3	IpAddress	monitor
dhcpCip	IpAddress	monitor
dhcpClientEnable	Integer	manage and/or monitor
dhcpClientLease	TimeTicks	monitor
dhcpCSMask	IpAddress	monitor
dhcpDfltRterIP	IpAddress	monitor
dhcpDomName	DisplayString	monitor
dhcpIPStart	IpAddress	manage and/or monitor
dhcpNumIPsToLease	Integer	manage and/or monitor
dhcpServerEnable	Integer	manage and/or monitor
dhcpServerLeaseTime	Integer	manage and/or monitor
dhcpServerTable	DhcpServerEntry	monitor
dhcpSip	IpAddress	monitor
dmzEnable	Integer	manage and/or monitor
dmzIP	IpAddress	manage and/or monitor
dnsAutomatic	Integer	manage and/or monitor
enable8023link	Integer	manage and/or monitor
hostIp	IpAddress	monitor
hostLease	TimeTicks	monitor
hostMacAddress	PhysAddress	monitor
jitter	Integer	monitor
lanIp	IpAddress	manage and/or monitor
lanMask	IpAddress	manage and/or monitor
naptEnable	Integer	manage and/or monitor
naptPrivateIP	IpAddress	manage and/or monitor
naptPrivateSubnetMask	IpAddress	manage and/or monitor
naptPublicGatewayIP	IpAddress	manage and/or monitor
naptPublicIP	IpAddress	manage and/or monitor

Object Name	Value Syntax	Operation Allowed
naptPublicSubnetMask	IpAddress	manage and/or monitor
naptRFPublicGateway	IpAddress	manage and/or monitor
naptRFPublicIP	IpAddress	manage and/or monitor
naptRFPublicSubnetMask	IpAddress	manage and/or monitor
networkAccess	Integer	manage and/or monitor
powerUpMode	Integer	manage and/or monitor
prefferedDNSIP	IpAddress	manage and/or monitor
radioDbm	DisplayString	monitor
radioSlicing	Integer	monitor
radioTxGain	Integer	monitor
registeredToAp	DisplayString	monitor
rfScanList	DisplayString	manage and/or monitor
rssi	Integer	monitor
sessionStatus	DisplayString	monitor
tcpGarbageCollectTmout	Integer	manage and/or monitor
timingPulseGated	Integer	manage and/or monitor
udpGarbageCollectTmout	Integer	manage and/or monitor

Ports Designations in SNMP

SNMP identifies the ports of the module as follows:

- Interface 1 represents the RF interface of the module. To monitor the status of Interface 1 is to monitor the traffic on the RF interface.
- Interface 2 represents the Ethernet interface of the module. To monitor the status of Interface 2 is to monitor the traffic on the Ethernet interface.

These interfaces can be viewed on the NMS through definitions that are provided in the standard MIB files.

4.7.12 Traps Provided in the Canopy Enterprise MIB

Canopy modules provide the following SNMP traps for automatic notifications to the NMS:

- whispGPSInSync, which signals a transition from not synchronized to synchronized.
- whispGPSOutSync, which signals a transition from synchronized to not synchronized.
- whispRegComplete, which signals registration complete.
- whispRegLost, which signals registration lost.

4.7.13 MIB Viewers

Any of several commercially available MIB viewers can facilitate management of these objects through SNMP. Some are available as open source software. The Canopy division does not endorse, support, or discourage the use of any these viewers.

To assist end users in this area, the Canopy division offers a starter guide for one of these viewers—MRTG (Multi Router Traffic Grapher). This starter guide is titled ***Canopy*** *Network Management with MRTG: Application Note*, and is available in the Library section under Support at http://www.motorola.com/canopy. MRTG software is available at http://mrtg.hdl.com/mrtg.html.

Other MIB viewers are available and/or described at the following web sites:

http://ns3.ndgsoftware.com/Products/NetBoy30/mibbrowser.html

http://www.adventnet.com/products/snmputilities/

http://www.dart.com/samples/mib.asp

http://www.edge-technologies.com/webFiles/products/nvision/index.cfm

http://www.ipswitch.com/products/whatsup/monitoring.html

http://www.koshna.com/products/KMB/index.asp

http://www.mg-soft.si/mgMibBrowserPE.html

http://www.mibexplorer.com

http://www.netmechanica.com/mibbrowser.html

http://www.networkview.com

http://www.newfreeware.com/search.php3?q=MIB+browser

http://www.nudesignteam.com/walker.html

http://www.oidview.com/oidview.html

http://www.solarwinds.net/Tools

http://www.stargus.com/solutions/xray.html

http://www.totilities.com/Products/MibSurfer/MibSurfer.htm

4.8 NAT, DHCP SERVER, DHCP CLIENT, AND DMZ IN SM

In Release 4.1 and later releases, the Canopy system provides NAT (network address translation for SMs in the following combinations of NAT and DHCP (Dynamic Host Confiuration Protocol):

- NAT Disabled (as in earlier releases)
- NAT with DHCP Client and DHCP Server
- NAT with DHCP Client
- NAT with DHCP Server
- NAT without DHCP

4.8.1 NAT

NAT isolates the SMs from the Internet. This both enhances SM security and obviates the need for a special assignment scheme of IP addresses that identify the SMs. Where NAT is active, the SM serves as a Layer 3 switch. (By contrast, where NAT is not active, the SM serves as a Layer 2 bridge.)

In the Canopy system, NAT supports HTTP, ICMP (Internet Control Message Protocols), and FTP (File Transfer Protocol), but *does not* support IPsec (IP Secure).

4.8.2 DHCP

DHCP enables a device to be assigned a new IP address and TCP/IP parameters, including a default gateway, whenever the device reboots. Thus DHCP reduces configuration time, conserves IP addresses, and allows modules to be moved to a different network within the Canopy system.

In conjunction with the NAT features, each SM provides

- a DHCP server that assigns IP addresses to computers connected to the SM by Ethernet protocol.
- a DHCP client that receives an IP address for the SM from a network DHCP server.

4.8.3 NAT Disabled

The NAT Disabled implementation is illustrated in Figure 12.

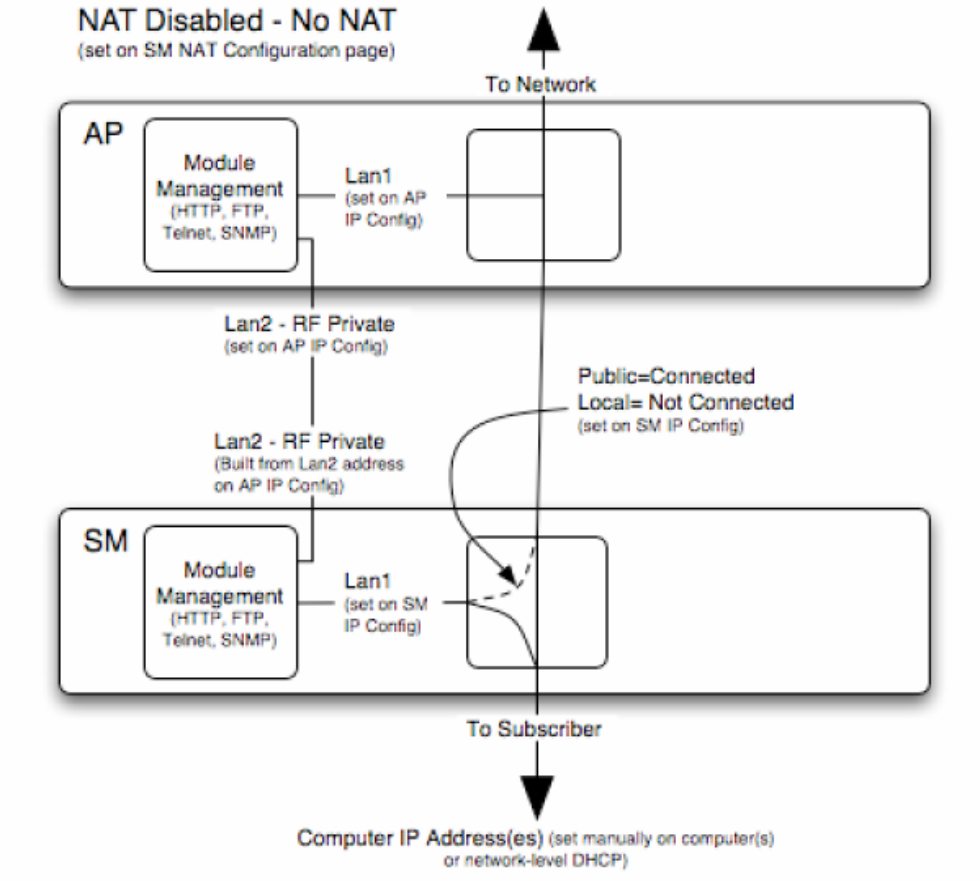


Figure 12: NAT Disabled implementation

This implementation is provisioned as displayed in Figure 38: IP Configuration screen, NAT disabled on Page 92 and Figure 44: NAT Configuration screen, NAT disabled on Page 99.

4.8.4 NAT with DHCP Client and DHCP Server

The NAT with DHCP Client and DHCP Server implementation is illustrated in Figure 13.

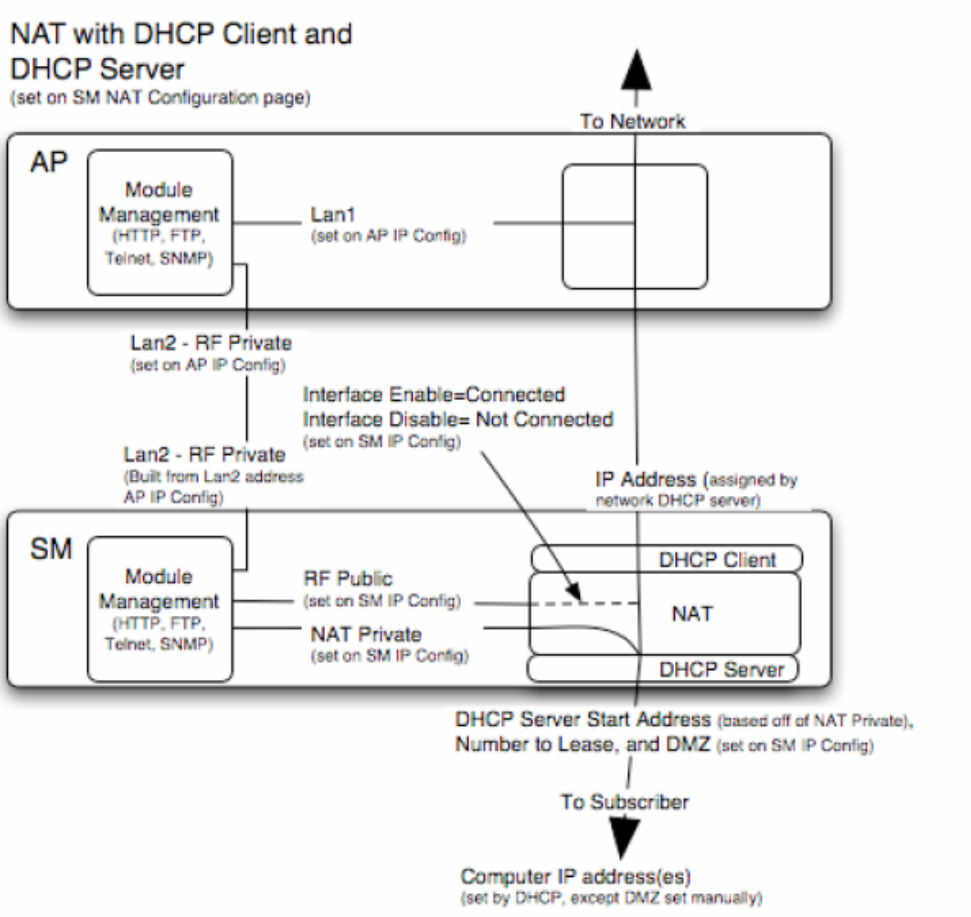


Figure 13: NAT with DHCP Client and DHCP Server implementation

This implementation is provisioned as displayed in Figure 40: IP Configuration screen, NAT with DHCP client and DHCP server on Page 94 and Figure 45: NAT Configuration screen, NAT with DHCP client and DHCP server on Page 101.

4.8.5 NAT with DHCP Client

The NAT with DHCP Client implementation is illustrated in Figure 14.

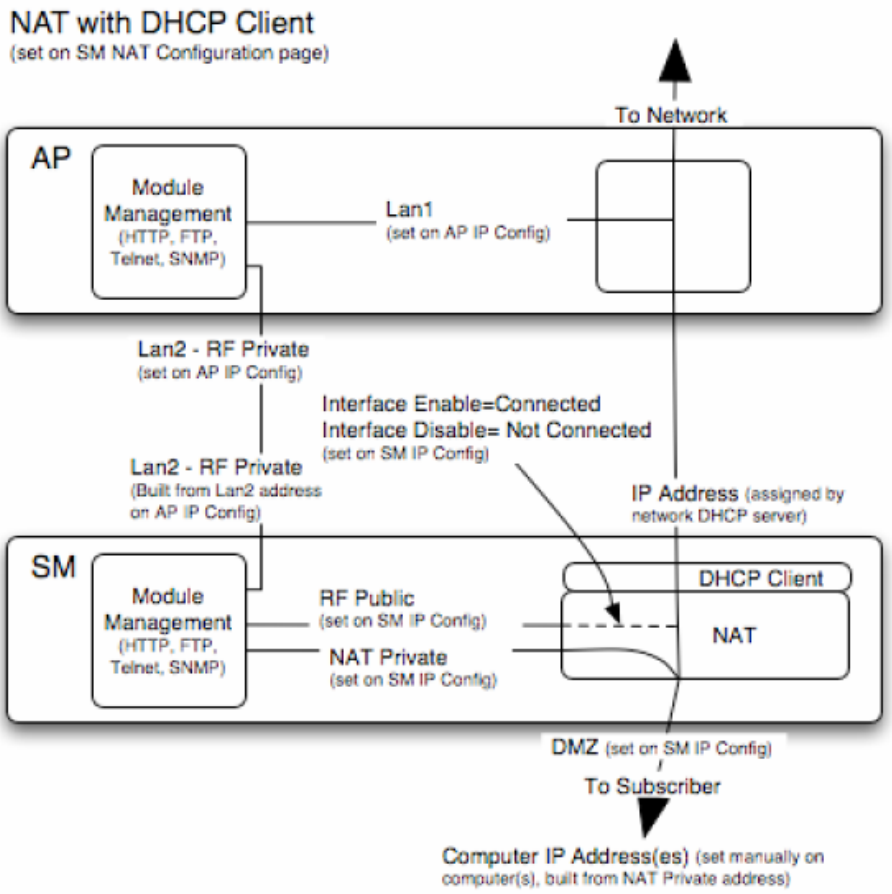


Figure 14: NAT with DHCP Client implementation

This implementation is provisioned as displayed in Figure 41: IP Configuration screen, NAT with DHCP client on Page 95 and Figure 46: NAT Configuration screen, NAT with DHCP client on Page 102.

4.8.6 NAT with DHCP Server

The NAT with DHCP Server implementation is illustrated in Figure 15.

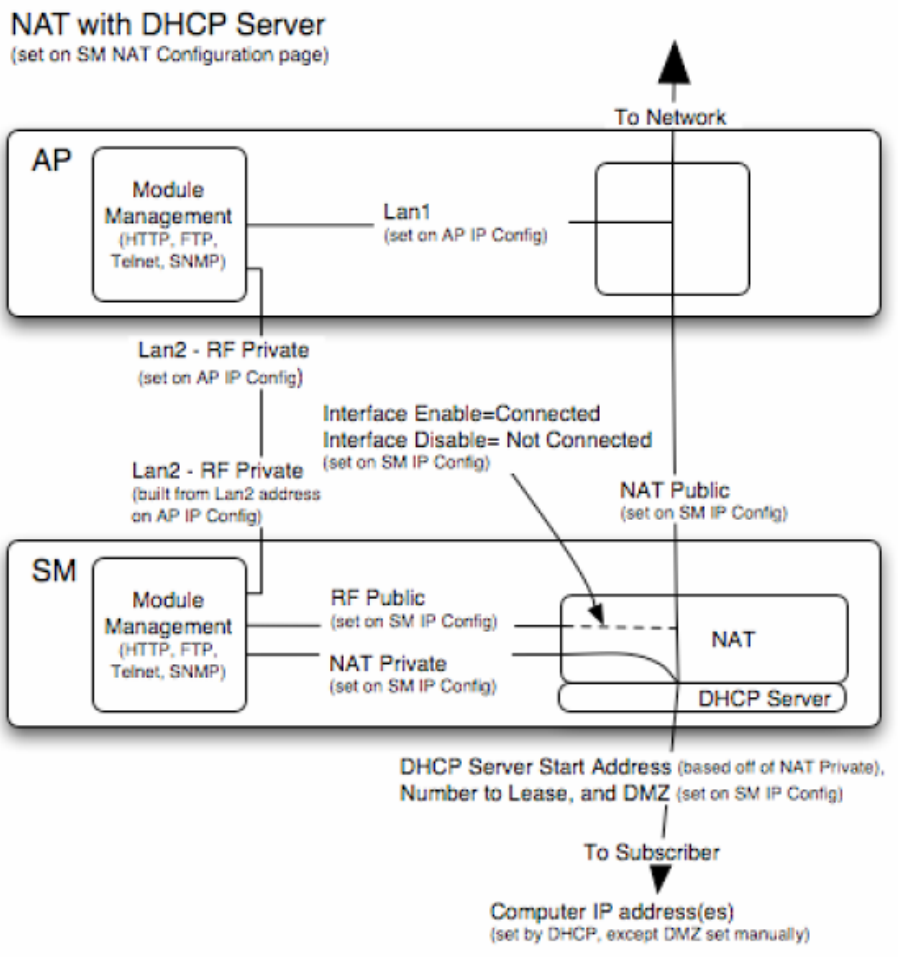


Figure 15: NAT with DHCP Server implementation

This implementation is provisioned as displayed in Figure 42: IP Configuration screen, NAT with DHCP server on Page 96 and Figure 47: NAT Configuration screen, NAT with DHCP server on Page 103.

4.8.7 NAT without DHCP

The NAT without DHCP implementation is illustrated in Figure 16.

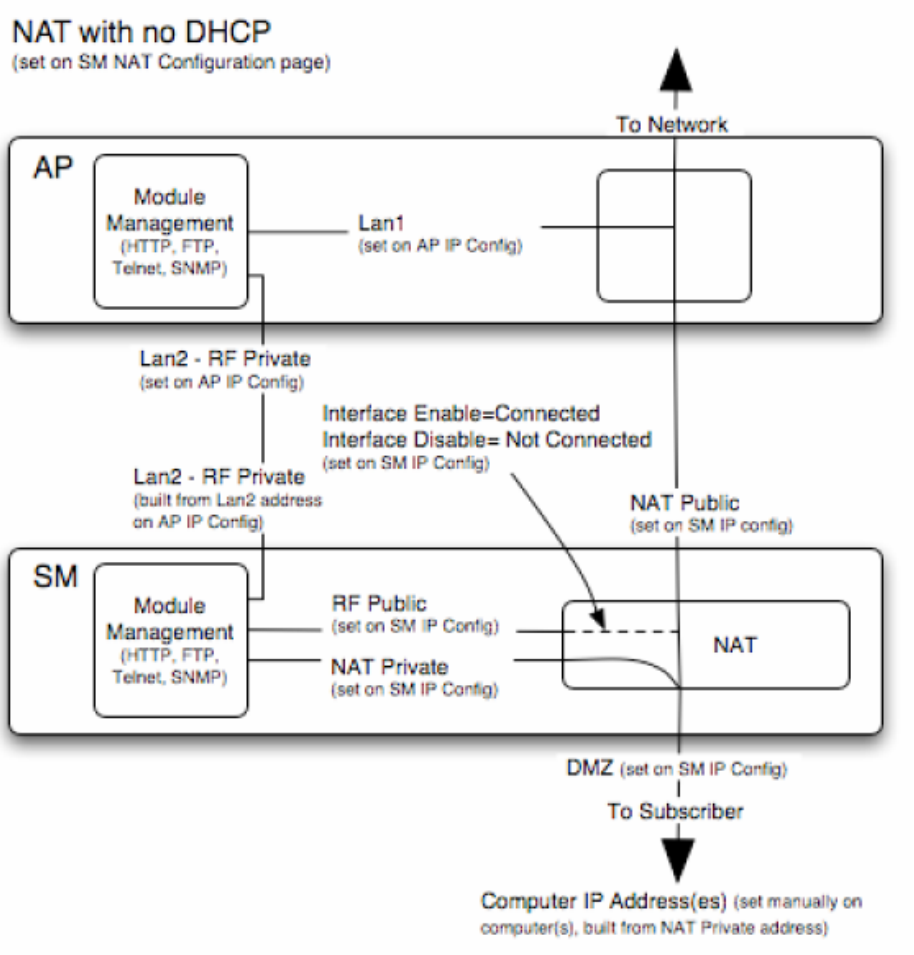


Figure 16: NAT without DHCP implementation

This implementation is provisioned as displayed in Figure 43: IP Configuration screen, NAT without DHCP on Page 97 and Figure 48: NAT Configuration screen, NAT without DHCP on Page 104.

4.8.8 DMZ

In conjunction with the NAT features, a DMZ (demilitarized zone) allows the assignment of one IP address behind the SM for a device to logically exist outside the firewall and receive network traffic. The first three octets of this IP address must be identical to the first three octets of the NAT private IP address.

5 SITE PLANNING

The following considerations are critical in the choice of a location for the wireless network infrastructure.

Note: Since each site is unique, typically many additional considerations are critical.

5.1 SELECTION OF SM TYPES AND PASSIVE REFLECTORS

A system plan may include

- SMs that *are not* mounted to Passive Reflectors, operate in the 5.2-GHz band, and communicate with an AP in the 5.2-GHz band.
- SMs that *are not* mounted to Passive Reflectors, operate in either the 2.4-GHz band or the 5.7-GHz band, and communicate with an AP in the same band.
- SMs that are mounted to Passive Reflectors, operate in the 2.4-GHz band or the 5.7-GHz band, and communicate with an AP in the same band.

The network planner should select the model of SM for each site based on

- an attempt to design for cross-band collocation of APs with BH timing masters (to avoid self-interference). See Physical Proximity on Page 58.
- the constraint that both the AP and the SM must operate on the same encryption standard. See Interoperability on Page 22.
- the distance of the SM from the AP. A Passive Reflector is required for each SM in the 5.7-GHz band that is further than 2 miles (3.2 km) from the AP and for each SM in the 2.4-GHz band that is further than 5 miles (8 km) from the AP.

See Types of SM Applications on Page 16.

5.2 SPECIFIC MOUNTING CONSIDERATIONS

The Canopy SM must be mounted

- vertically (the internal antenna is vertically polarized).
- with hardware that the wind and ambient vibrations cannot flex or move.
- where a grounding system is available.
- at a proper height:
  - higher than the tallest points of objects immediately around them (such as trees and buildings).
  - at least 2 feet (0.6 m) below the tallest point on the roof or antenna mast (for lightning protection).
- in a line-of-sight path
  - to the AP in the RF link.
  - that will not be obstructed by trees as they grow or structures that are later built.

    Note: Visual line of sight does not guarantee radio line of sight.

5.2.1 Lightning Protection

The network plan must include lightning protection. The following precautions are strongly recommended:

- Install a lightning protection system for the site.
- Observe all local and national codes that apply to grounding for lightning protection.
- Use a Canopy Surge Suppressor to protect equipment from surges on the Ethernet cable that is connected to the Canopy System.

5.2.2 Electrical Requirements

The network plan must also conform to applicable country and local codes, such as the NEC (National Electrical Code) in the U.S.A. If uncertain of code requirements, the planner should engage the services of a licensed electrician.

5.3 GENERAL RF CONSIDERATIONS

The network planner must account for the following general characteristics of RF transmission and reception.

5.3.1 Vertical Beam Width

The transmitted beam in the vertical dimension covers more area beyond the beam center. The Canopy System Calculator page BeamwidthRadiiCalcPage.xls automatically calculates the radii of the beam coverage area. Figure 17 displays an image of this file.

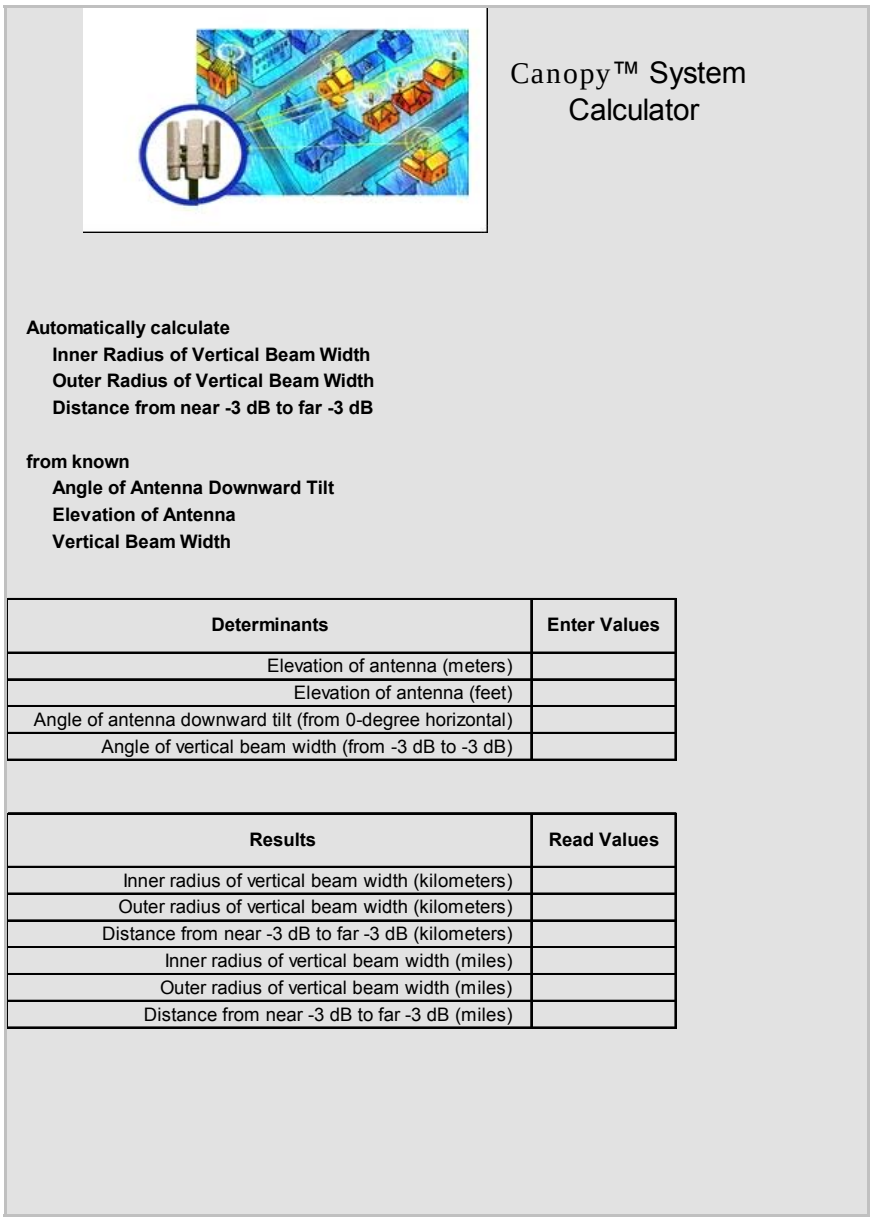


Figure 17: Canopy System Calculator page for beam width

5.3.2 Radio Horizon

Because the surface of the earth is curved, higher module elevations are required for greater link distances. This effect can be critical to link connectivity in link spans that are greater than 8 miles (12 km). The Canopy System Calculator page AntennaElevationCalcPage.xls automatically calculates the minimum antenna elevation for these cases, presuming no landscape elevation difference from one end of the link to the other. Figure 18 displays an image of this file.

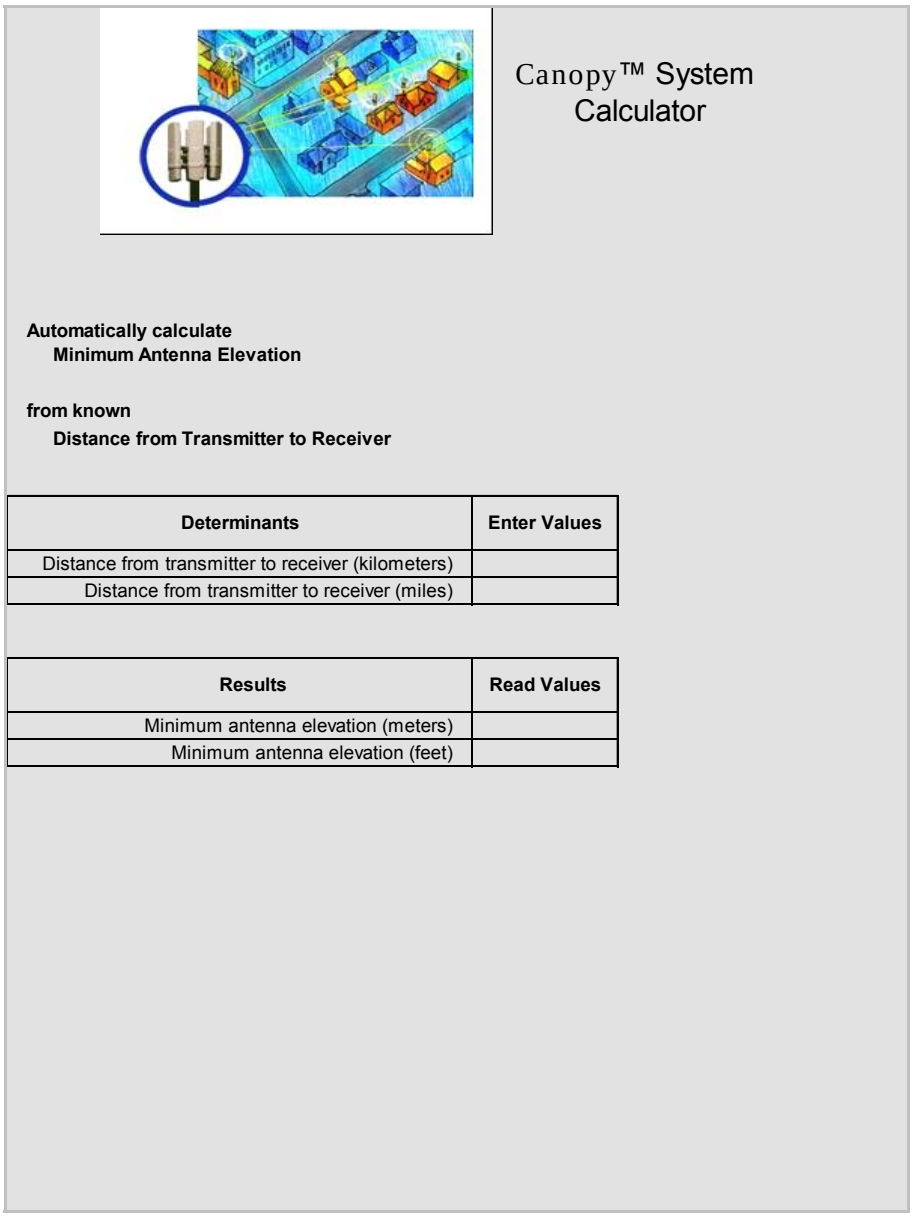


Figure 18: Canopy System Calculator page for antenna elevation

5.3.3 Antenna Downward Tilt

The appropriate angle of antenna downward tilt is derived from both the distance between transmitter and receiver and the difference in their elevations. The Canopy System Calculator page DowntiltCalcPage.xls automatically calculates this angle. Figure 19 displays an image of this file.

Canopy™ System Calculator

Automatically calculate
Angle of Antenna Downward Tilt

from known
Distance from Transmitter to Receiver
Elevation of Transmitter
Elevation of Receiver

Determinants	Enter Values
Distance from transmitter to receiver (kilometers)	
Elevation of transmitter (meters)	
Elevation of receiver (meters)	
Distance from transmitter to receiver (miles)	
Elevation of transmitter (feet)	
Elevation of receiver (feet)	

Results	Read Values
Angle of antenna downward tilt (from metric calculation)	
Angle of antenna downward tilt (from English standard calculation)	

Figure 19: Canopy System Calculator page for antenna downward tilt

5.3.4 Fresnel Loss

The Fresnel (pronounced *fre·NEL*) Zone is a theoretical three-dimensional area around the line of sight of an antenna transmission. Objects that penetrate this area can cause the received signal strength of the transmitted signal to fade. Out-of-phase reflections and absorption of the signal result in signal cancellation.

An unobstructed line of sight is important, but is not the *only* determinant of adequate placement. Even where the path has a clear line of sight, obstructions such as terrain, vegetation, metal roofs, or cars may penetrate the Fresnel zone and cause signal loss. Figure 20 illustrates an ideal Fresnel zone.

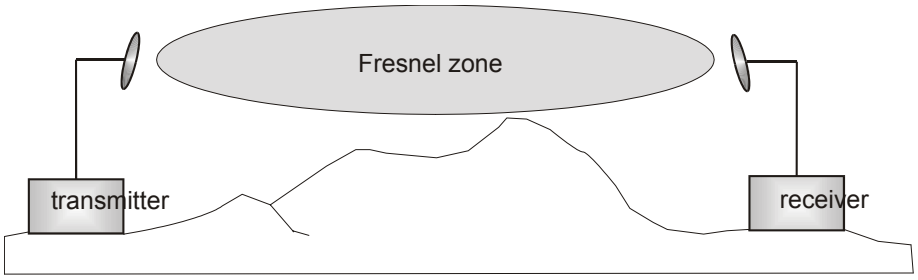


Figure 20: Fresnel zone

The Canopy System Calculator page FresnelZoneCalcPage.xls automatically calculates the Fresnel zone clearance that is required between the visual line of sight and the top of a high-elevation object in the link path. Figure 21 displays an image of this file.

Canopy™ System Calculator

Automatically calculate
Fresnel Zone (vertical dimension)

from known
Distance from Transmitter to Receiver
Distance from High-elevation Object to Receiver
Frequency

Determinants	Enter Values
Distance from transmitter to receiver (kilometers)	
Distance from high-elevation object to receiver (kilometers)	
Distance from transmitter to receiver (miles)	
Distance from high-elevation object to receiver (miles)	
Frequency (GHz)	

Results	Read Values
Maximum Fresnel zone radius, midway between Tx and Rx (meters)	
Fresnel zone radius at object (meters)	
Minimum clearance required beween line of sight and top of object (meters)	
Maximum Fresnel zone radius, midway between Tx and Rx (feet)	
Fresnel zone radius at object (feet)	
Minimum clearance required beween line of sight and top of object (feet)	

Figure 21: Canopy System Calculator page for Fresnel zone dimensions

5.3.5 Free Space Path Loss

An RF signal in space is attenuated by atmospheric and other effects as a function of the distance from the initial transmission point. The further a reception point is placed from the transmission point, the weaker is the received RF signal.

Free space path loss is a major determinant in Rx (received) signal level. Rx signal level, in turn, is a major factor in the system operating margin (fade margin), which is calculated as follows:

system operating margin = *Rx signal level* − Rx sensitivity

The Rx sensitivity of the SM is stated under SM MODULE SPECIFICATIONS on Page 117. The determinants in Rx signal level are illustrated in Figure 22.

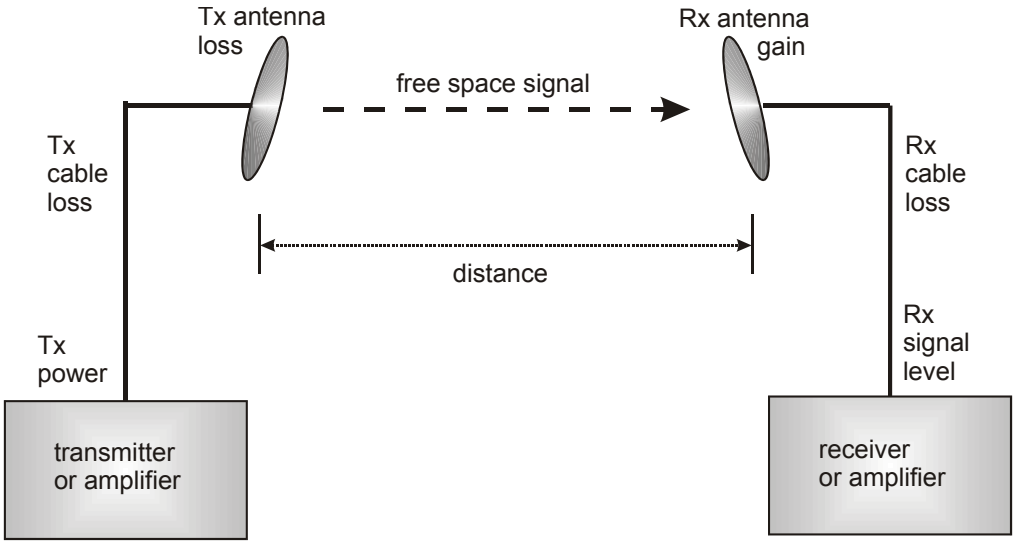


Figure 22: Determinants in Rx signal level

Rx signal level is calculated as follows:

Rx signal level dB = *Tx power* − *Tx cable loss* + *Tx antenna gain* − *free space path loss*
+ *Rx antenna gain* − *Rx cable loss*

NOTE: This Rx signal level calculation presumes that a clear line of sight is established between the transmitter and receiver and that no objects encroach in the Fresnel zone.

The Canopy System Calculator page PathLossCalcPage.xls automatically calculates free space path loss. Figure 23 displays an image of this page.

Figure 23: Canopy System Calculator page for path loss

5.3.6 Loss Due to Foliage

The foliage of trees and plants causes additional signal loss. Seasonal density, moisture content of the foliage, and other factors such as wind may change the amount of loss. Caution should be exercised when a link is used to transmit though this type of environment.

5.3.7 Carrier-to-Interference Ratio

The C/I (Carrier-to-Interference) ratio defines how much signal advantage must be engineered into the radio link to tolerate an interfering transmission.

Note: The C/I ratio is typically a design feature of the radio.

5.4 CANOPY COMPONENT PROLIFERATION

The network planner must account for the coordination of both initial and future Canopy modules.

5.4.1 Subscriber Modules

The planner must always consider the distribution of SMs as relative to the distribution of APs and clusters. The planner must also consider that the SMs and the AP to which they register should operate on the same software release. See AP Update of SM Software Release on Page 56.

5.4.2 Access Point Modules

The number of APs deployed can vary from site to site, based on the locations of SMs that these modules must reach. The mounting scheme can also vary from site to site. The APs need not be mounted adjacent to each other. For example, on a three-legged tower, two APs can be mounted to each tower leg.

5.4.3 Access Point Clusters

Each AP cluster requires a CMM for seamless operation within the entire Canopy system. Thus the network planner should consider the number and locations of CMMs that will be deployed as the Canopy network grows.

5.4.4 Backhaul Modules

The network planner should consider where BHs will be required

- to connect the Canopy system to the outer network.
- to span distances with a wireless link (see Types of SM Applications on Page 16).
- to generate and deliver network sync to a site (see Synchronization on Page 18).
- to pass network sync in one additional link to a remote site (see Synchronization on Page 18).

The network planner should also consider the frequency band of each BH that will be deployed

- to avoid self-interference (see Physical Proximity on Page 58).
- to use the extended range that the Canopy Passive Reflector dish provides (see Types of SM Applications on Page 16 and Selection of SM Types and Passive Reflectors on Page 47).

5.5 AP UPDATE OF SM SOFTWARE RELEASE

In Release 4.1 and later releases, the operator can upgrade to a later release any SM that operates on Release 4.0 or later. To do so, the operator uses the FTP (File Transfer Protocol) and `telnet` utilities. The interval required for each SM update is approximately four minutes.

Procedure 5: Auto-updating SMs

To upgrade SMs to a later release, the operator performs the following steps:

1. FTP the file SMboot.bin, FPGA, and the action list to AP, as shown in Figure 24.

```
< ls
062403_D40.jbc APASboot.bin BH10boot.bin
SMboot.bin
41actionlist.txt APboot.bin BH20boot.bin
> ftp 172.16.1.1
Connected to 172.16.1.1.
220 FTP server ready
Name (172.16.1.1:user):
331 Guest login ok
Password:
230 Guest login ok, access restrictions apply.
Remote system type is Type:.
ftp> binary
200 Type set to I.
ftp> put SMboot.bin
local: SMboot.bin remote: SMboot.bin
500 'EPSV': command not understood.
227 Entering Passive Mode (172,16,1,1,4,1)
150 Opening BINARY mode data connection for SMboot.bin
100% |************************************| 712 KB 229.55
KB/s 00:00 ETA
226 Transfer complete.
729668 bytes sent in 00:03 (209.57 KB/s)
ftp> put 062403_D40.jbc
local: 062403_D40.jbc remote: 062403_D40.jbc
227 Entering Passive Mode (172,16,1,1,4,2)
150 Opening BINARY mode data connection for 062403_D40.jbc
100% |************************************| 156 KB 219.48
KB/s 00:00 ETA
226 Transfer complete.
159859 bytes sent in 00:00 (156.18 KB/s)
ftp> put 41actionlist
local: 41actionlist remote: 41actionlist
ftp: local: 41actionlist: No such file or directory
ftp> put 41actionlist.txt
local: 41actionlist.txt remote: 41actionlist.txt
227 Entering Passive Mode (172,16,1,1,4,3)
150 Opening BINARY mode data connection for 41actionlist.txt
100% |************************************| 53 58.81
KB/s 00:00 ETA
226 Transfer complete.
53 bytes sent in 00:00 (0.25 KB/s)
ftp> exit
221 Goodbye.
```

Figure 24: FTP to AP for SM auto-update

2. Update the SMs in a `telnet` session to the AP, as shown in Figure 25.

```
> telnet 172.16.1.1
Trying 172.16.1.1...
Connected to 172.16.1.1.
Escape character is '^]'.
/---------\
C A N O P Y
Motorola Broadband Wireless Technology Center
(Copyright 2001, 2002 Motorola Inc.)
Telnet+> update 41actionlist.txt
```

Figure 25: Telnet to AP for SM auto-update

3. In the **Canopy Boot Version** field of the Status page of each SM that was targeted for update, confirm that the SM has been updated.
4. Turn off updating in a `telnet` session to the AP, as shown in Figure 26.

   RESULT: All SMs that are registered to the AP are upgraded to the later release.

```
> telnet 172.16.1.1
Trying 172.16.1.1...
Connected to 172.16.1.1.
Escape character is '^]'.
/---------\
C A N O P Y
Motorola Broadband Wireless Technology Center
(Copyright 2001, 2002 Motorola Inc.)
Telnet+> updateoff
Back on the original Telnet session:
13:15:40 UT : 11/10/03 : AutoUpdate currently Disabled.
Telnet+>
```

Figure 26: Telnet to AP to turn off SM auto-update

5.6 CHANNEL PLANS

For 5.2- and 5.7-GHz modules, 20-MHz wide channels are centered every 5 MHz. For 2.4-GHz modules, 20-MHz wide channels are centered every 2.5 MHz. This allows the operator to customize the channel layout for interoperability where other Canopy equipment is collocated.

Regardless of whether 2.4-, 5.2-, or 5.7-GHz modules are deployed, channel separation between modules should be at least 20 MHz.

5.6.1 Physical Proximity

A BH and an AP that operate in the same frequency band should be separated by at least 100 feet (30 meters). At closer distances, the frame structures that these modules transmit and receive cause interference.

A BH and an AP on the same tower, or separated by less than 100 feet (30 meters), require a CMM. The CMM properly synchronizes all Canopy modules to prevent interference and desensing of the modules.

> ***NOTE:*** Cross-band deployment of APs and BH is the recommended alternative (for example, a 5.2-GHz AP collocated with 5.7-GHz BH).

5.6.2 Spectrum Analysis

In Release 4.1 and later releases, the operator can

- use an SM as a spectrum analyzer.
- view a table that shows power level in RSSI and dBm for each frequency throughout the entire 20-MHz range, regardless of limited selections in the **Custom RF Frequency Scan Selection List** field of the Configuration page.
- select an AP channel that minimizes interference from other RF equipment.

This functionality can be used during the alignment of an SM, but is especially helpful for frequency selection during site planning.

The following procedure causes the SM to drop any active RF link. If a link is dropped when the spectrum analysis begins, the link can be re-established after a 15-minute interval has elapsed.

Procedure 6: Enabling spectrum analysis

The Spectrum Analyzer in SM and BHS feature provides this functionality. To enable this functionality, the operator performs the following steps:

1. Access the Expanded Stats page of the SM.
2. On the Expanded Stats page, click **Spectrum Analyzer**.
3. On the Spectrum Analyzer page, click **Enable**.

   RESULT: The feature is enabled.
4. Click **Enable** again.

   RESULT: The system measures RSSI and dBm for each frequency.
5. Repeatedly click **Enable**.

   RESULT: The system repeats the measurement and refreshes the displayed data until the spectrum analysis mode times out, 15 minutes after the mode was invoked in Step 3.

5.6.3 Power Reduction to Mitigate Interference

In Release 4.1 and later releases, where any module (SM, AP, BH timing master, or BH timing slave) is close enough to another module that self-interference is possible, the operator can set the SM to operate at 18 dB less than full power.

The following procedure can cause the SM to drop an active RF link to a module that is too far from the low-power SM. If a link is dropped when Power Control is set to low, the link can be re-established by only Ethernet access.

Procedure 7: Invoking the low power mode

The Power Control feature provides this functionality. To enable this functionality, the operator performs the following steps:

1. Access the Configuration page of the module.
2. In the **Power Control** parameter, click **Low**.
3. Click **Save Changes**.
4. Click **Reboot**.
5. Access the Alignment page of the SM.
6. Assess whether the desired links for this module achieve
   - RSSI greater than 700.
   - jitter value between 0 and 4 in Release 4.0 and later releases or between 5 and 9 in any earlier release.
7. Access the Link Test page of the module.
8. Assess whether the desired links for this module achieve
   - uplink efficiency greater than 90%.
   - downlink efficiency greater than 90%.
9. If the desired links fail to achieve any of the above measurement thresholds, then
   a. access the module by direct Ethernet connection.
   b. access the Configuration page of the module.
   c. in the **Power Control** parameter, click **Full**.
   d. click **Save Changes**.

5.6.4 2.4-GHz Channels

Channel selections for the AP in the 2.4-GHz band depend on whether the AP is deployed in cluster. Channel selections for the BH are not similarly limited.

2.4-GHz BH and Single AP Available Channels

A BH or a single 2.4-GHz AP can operate in the following channels, which are separated by only 2.5-MHz increments.

(All Frequencies in GHz)

2.4150	2.4275	2.4400	2.4525
2.4175	2.4300	2.4425	2.4550
2.4200	2.4325	2.4450	2.4575
2.4225	2.4350	2.4475	
2.4250	2.4375	2.4500	

The channels of *adjacent* 2.4-GHz APs should be separated by at least 20 MHz.

2.4-GHz AP Cluster Recommended Channels

Three non-overlapping channels are recommended for use in a 2.4-GHz AP cluster:

(All Frequencies in GHz)

2.4150	2.4350	2.4575

This recommendation allows 20 MHz of separation between one pair of channels and 22.5 MHz between the other pair. The network planner can use the Spectrum Analysis feature in an SM or BHS, or use a standalone spectrum analyzer, to evaluate the RF environment. Where spectrum analysis identifies risk of interference for any of these channels, the planner can compromise this recommendation as follows:

- Select 2.4375 GHz for the middle channel
- Select 2.455 GHz for the top channel
- Select 2.4175 GHz for the bottom channel

In any case, the plan should allow at least 20 MHz of separation between channels. See Spectrum Analysis on Page 59.

5.6.5 5.2-GHz Channels

Channel selections for the AP in the 5.2-GHz band depend on whether the AP is deployed in cluster. Channel selections for the BH are not similarly limited.

5.2-GHz BH and Single AP Available Channels

A BH or a single 5.2-GHz AP can operate in the following channels, which are separated by 5-MHz increments.

(All Frequencies in GHz)

5.275	5.290	5.305	5.320
5.280	5.295	5.310	5.325
5.285	5.300	5.315	

The channels of *adjacent* APs should be separated by at least 20 MHz. However, 25 MHz of separation is advised.

5.2-GHz AP Cluster Recommended Channels

Three non-overlapping channels are recommended for use in a 5.2-GHz AP cluster:

(All Frequencies in GHz)

5.275	5.300	5.325

5.6.6 5.7-GHz Channels

Channel selections for the AP in the 5.7-GHz band depend on whether the AP is deployed in cluster. Channel selections for the BH are not similarly limited.

5.7-GHz BH and Single AP Available U-NII Channels

A BH or a single 5.7-GHz AP can operate in the following U-NII channels, which are separated by 5-MHz.

(All Frequencies in GHz)

5.745	5.765	5.785	5.805
5.750	5.770	5.790	
5.755	5.775	5.795	
5.760	5.780	5.800	

The channels of *adjacent* APs should be separated by at least 20 MHz. However, Canopy advises 25-MHz separation.

5.7-GHz AP Cluster Recommended U-NII Channels

Four non-overlapping U-NII channels are recommended for use in a 5.7-GHz AP cluster:

(All Frequencies in GHz)

5.745	5.765	5.785	5.805

The fully populated cluster requires only three channels, each reused by the module that is mounted 180° opposed. The four channels above are also used for backhaul point-to-point links.

5.7-GHz BH and Single AP Available ISM/U-NII Channels

A BH or a single 5.7-GHz AP enabled for ISM/U-NII frequencies can operate in the following channels, which are separated by 5-MHz increments.

(All Frequencies in GHz)

5.735	5.765	5.795	5.825
5.740	5.770	5.800	5.830
5.745	5.775	5.805	5.835
5.750	5.780	5.810	5.840
5.755	5.785	5.815	
5.760	5.790	5.820	

The channels of *adjacent* APs should be separated by at least 20 MHz. However, 25 MHz of separation is advised.

5.7-GHz AP Cluster Recommended ISM/U-NII Channels

Six non-overlapping ISM/U-NII channels are recommended for use in a 5.7-GHz AP cluster:

(All Frequencies in GHz)

5.735	5.775	5.815
5.755	5.795	5.835

The fully populated cluster requires only three channels, each reused by the module that is mounted 180° offset. The six channels above are also used for backhaul point-to-point links.

As noted above, a 5.7-GHz AP enabled for ISM/U-NII frequencies can operate on a frequency as high as 5.840 GHz. Where engineering plans allow, this frequency can be used to provide an additional 5-MHz separation between AP and BH channels.

5.6.7 Example Channel Plans for AP Clusters

Examples for assignment of frequency channels and sector IDs are provided in Table 7, Table 8, and Table 9. Each frequency is reused on the sector that is at a 180° offset. The entry in the Symbol column refers to the layout in Figure 27 on Page 65.

NOTE: The operator specifies the sector ID for the module as described under Sector ID on Page 108.

Table 7: Example 2.4-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	2.4150 GHz	0	A
Northeast (60°)	2.4350 GHz	1	B
Southeast (120°)	2.4575 GHz	2	C
South (180°)	2.4150 GHz	3	A
Southwest (240°)	2.4350 GHz	4	B
Northwest (300°)	2.4575 GHz	5	C

Table 8: Example 5.2-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	5.275 GHz	0	A
Northeast (60°)	5.300 GHz	1	B
Southeast (120°)	5.325 GHz	2	C
South (180°)	5.275 GHz	3	A
Southwest (240°)	5.300 GHz	4	B
Northwest (300°)	5.325 GHz	5	C

Table 9: Example 5.7-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	5.735 GHz	0	A
Northeast (60°)	5.755 GHz	1	B
Southeast (120°)	5.775 GHz	2	C
South (180°)	5.735 GHz	3	A
Southwest (240°)	5.755 GHz	4	B
Northwest (300°)	5.775 GHz	5	C

5.6.8 Multiple Access Points Clusters

When deploying multiple AP clusters in a dense area, consider aligning the clusters as shown in Figure 27. However, this is only a recommendation. An installation may dictate a different pattern of channel assignments.

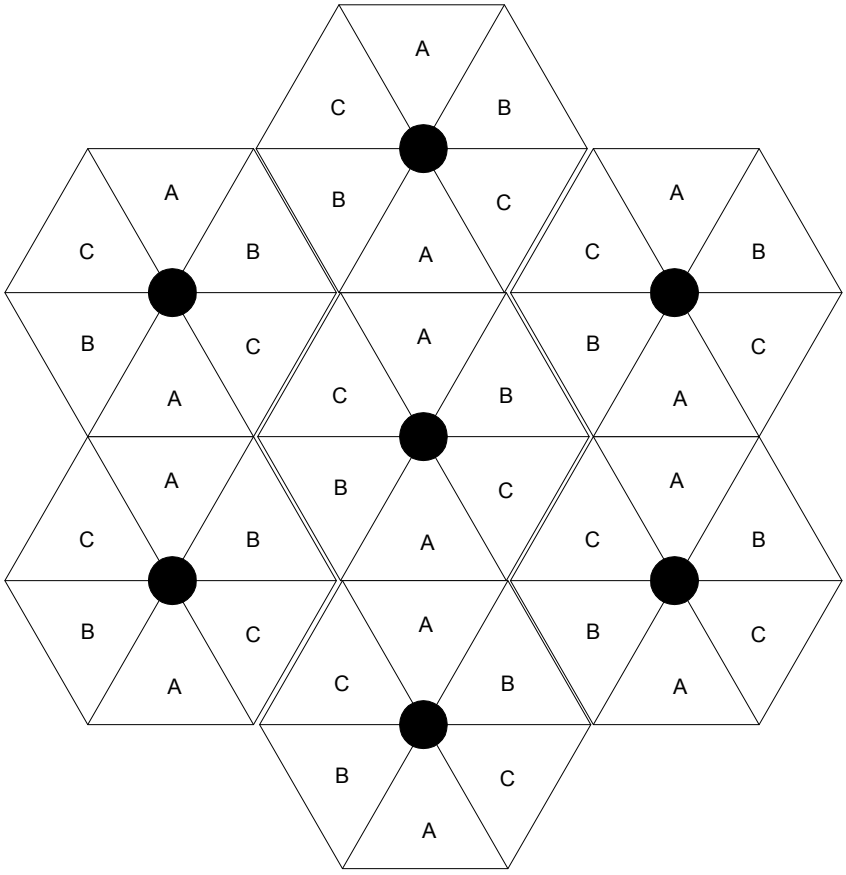


Figure 27: Example layout of 7 Access Point clusters

6 IP NETWORK PLANNING

A proper IP addressing method is critical to the operation and security of a Canopy network. The following information provides the background for the planner or operator to select an appropriate method.

6.1 GENERAL IP ADDRESSING CONCEPTS

Basic concepts of IP addressing and subnet masks are required for networking.

6.1.1 IP Address

The IP address is a 32-bit binary number that has four parts (octets). This set of four octets has two segments, depending on the class of IP address. The first segment identifies the network. The second identifies the hosts or devices on the network. The subnet mask marks a boundary between these two sub-addresses.

6.1.2 Subnet Mask

The subnet mask is a 32-bit binary number that filters the IP address. Where a subnet mask contains a bit set to 1, the corresponding bit in the IP address is part of the network address.

6.1.3 Example IP Address and Subnet Mask

In Figure 28, the first 16 bits of the 32-bit IP address identify the network:

	Octet 1	Octet 2	Octet 3	Octet 4
IP address 169.254.1.1	10101001	11111110	00000001	00000001
Subnet mask 255.255.0.0	11111111	11111111	00000000	00000000

Figure 28: Example of IP address in Class B subnet

In this example, the network address is 169.254, and 2^{16} (65,536) hosts are addressable.

6.1.4 Subnet Classes

A subnet is classified as either a Class A, Class B, or Class C network. Subnet masks that classify the network are shown in Table 10.

Table 10: Subnet masks for Network Classes A, B, and C

Class	Network Portion	Host Portion
A	11111111	00000000 00000000 00000000
B	11111111 11111111	00000000 00000000
C	11111111 11111111 11111111	00000000

Identification of Subnet Class

Subnet masks are not shipped in the IP packet. The packet contains only the 32-bit IP address of the destination. For this reason, information devices rely on assumption to distinguish between

- the portion of the IP address that identifies the network address
- the portion of the IP address that identifies the host.

IP systems developed a form of logic to make this determination:

- Class A network addresses always have the first bit of the IP address set to 0.
- Class B network addresses always have their first bit set to 1 and their second bit set to 0.
- Class C network addresses always have their first two bits set to 1 and the third bit set to 0.

With this logic, an information device can identify the subnet mask to apply to the IP address and where to route the data.

6.2 DYNAMIC OR STATIC ADDRESSING

For any computer to communicate with a Canopy module, the computer must be configured to either

- use DHCP (Dynamic Host Configuration Protocol). In this case, when not connected to the network, the computer derives an IP address on the 169.254 network within two minutes.
- have an assigned static IP address (for example, 169.254.1.5) on the 169.254 network.

  ***NOTE*:** If an IP address that is set in the SM is not the 169.254.x.x network address, then the network operator must assign the computer a static IP address in the same subnet.

6.2.1 When a DHCP Server is Not Found

The following is a synopsis of an Internet Draft available at http://www.ietf.org/internet-drafts/draft-ietf-zeroconf-ipv4-linklocal-05.txt. This draft describes how Microsoft and Apple operating systems react when a DHCP server is not found on the network.

To operate on a network, a computer requires an IP address, a subnet mask, and possibly a gateway address. Either a DHCP server automatically assigns this configuration information to a computer on a network or an operator must input these items.

When a computer is brought online and a DHCP server is not accessible (such as when the server is down or the computer is not plugged into the network), Microsoft and Apple operating systems default to an IP address of 169.254.x.x and a subnet mask of 255.255.0.0 (169.254/16).

6.3 SM MODULE ADDRESS ASSIGNMENT

Each SM requires an IP address on the network. This IP address is for only management purposes. For security, the SM should be either

- not assigned a routable IP address.
- assigned a routable IP address only if a firewall is present to protect the SM.

From the factory, each Canopy module—AP, BH, or SM—is assigned a unique MAC (Media Access Control) address and the following default networking information:

- IP address of 169.254.1.1
- Subnet mask of 255.255.0.0
- Network gateway of 169.254.0.0

6.3.1 Operator Assignment of IP Addresses

The Canopy network operator assigns IP (Internet Protocol) addresses to computers and network components, by either *static* or *dynamic* IP addressing. The operator also must identify the appropriate subnet mask and network gateway to each module. The SM requires a network-accessible IP address.

The operator must first know how the service provider assigns IP addresses on this network.

7 SM MODULE INSTALLATION

The following steps are required to install a Canopy SM:

1. Unpacking the Canopy Products. See Page 69.
2. Cabling the SM. See Page 70.
3. Configuring the SM. See Page 75.
4. Installing the SM. See Page 77.
5. Verifying System Performance. See Page 80.

7.1 UNPACKING THE CANOPY PRODUCTS

Upon receipt, carefully inspect all shipping boxes for signs of damage. If you find damage, immediately notify the transporatation company.

Unpack the equipment, making sure that all of the components ordered have arrived. Saving all the packing materials is recommended. These can be used to transport the equipment to and from installation sites.

7.1.1 Component Layout

The simple design of the Canopy SM allows for easy deployment. As shown Figure 29, the base cover of the module snaps off when a lever on the back of the base cover is depressed. This exposes the Ethernet and GPS sync connectors and diagnostic LEDs.

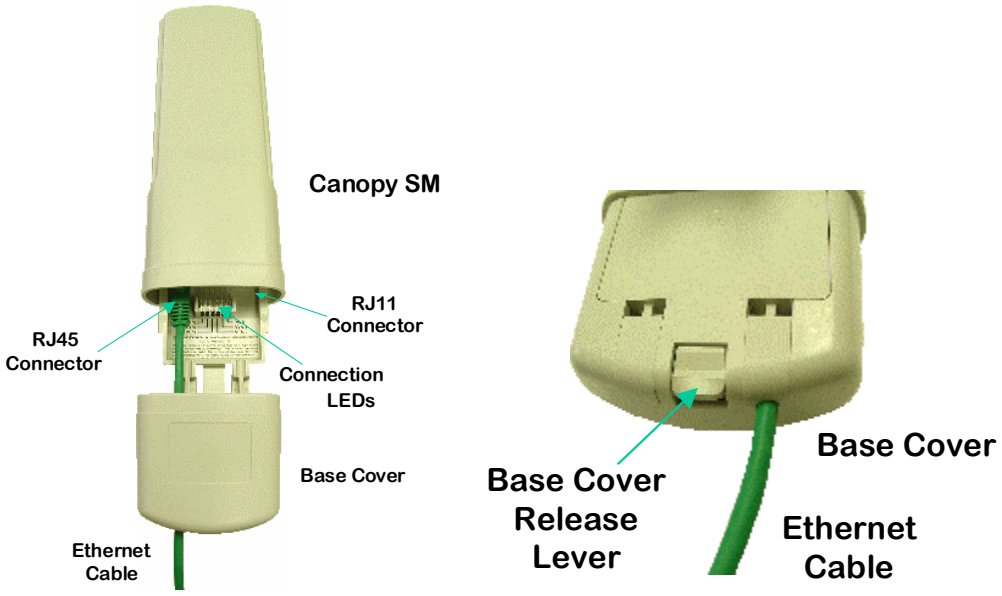


Figure 29: Canopy SM base cover, attached and detached

7.1.2 Diagnostic LEDs

The diagnostic LEDs report the following information about the current status of the SM, as described in Table 11 for the timing slave.

> ***NOTE*:** Table 11 identifies the LEDs in order of their left-to-right position as the cable connections face downward.

Table 11: SM status LEDs

Label	Color when Active	Status if Registered to an AP	Notes	
			Operating Mode	Aiming Mode
LNK/5	green	Ethernet link	Continuously lit when link is present.	These five LEDs act as a bar graph to indicate the relative quality of alignment. As RSSI (received signal strength indicator) and jitter improve during alignment, more of these LEDs are lit.
ACT/4	orange	Presence of data activity on the Ethernet link	Flashes during data transfer. Frequency of flash is not a diagnostic indication.	
GPS/3	red	*Unused*	If this SM is not registered to an AP, then these three LEDs cycle on and off from left to right.	
SES/2	green	*Unused*		
SYN/1	orange	Presence of sync		
PWR	red	DC power	Always lit when power is correctly supplied.	Always lit when power is correctly supplied.

7.2 CABLING THE SM

The use of shielded cable for all Canopy infrastructure associated with BHs, APs, and CMMs is *strongly* recommended. The environment these modules operate in often has significant unknown or varying RF energy. Operator experience consistently indicates that the additional cost of shielded cabling is more than compensated by predictable operation and reduced costs for troubleshooting and support.

7.2.1 Standards for Wiring

The following information describes the wiring standards for installing a Canopy system. All diagrams use the EIA/TIA-568B color standard.

Either RJ-45 straight-thru or RJ-45 crossover cable can be used to connect a (network interface card), hub, router, or switch to a module. Canopy modules that are currently available can auto-sense whether the Ethernet cable in a connection is wired as straight-thru or crossover. Some modules that were sold earlier do not.

Table 12 identifies by MAC address whether a module auto-senses the Ethernet cable type.

Table 12: Module auto-sensing per MAC address

Module Type	MAC Address (ESN) of Non Auto-sensing Module	MAC Address (ESN) of Auto-sensing Module
2.4-GHz modules	(no ESNs)	(all ESNs)
5.2 Modules	≤ 0a003e0021c8	≥ 0a003e0021c9
5.7 Modules	≤ 0a003ef00f79	≥ 0a003ef00f7a

Where a non auto-sensing module is used

- use an RJ-45 straight-thru cable to connect to a NIC (network interface card).
- use an RJ-45 crossover cable to connect to a hub, switch, or router.

Where the Canopy AC wall adapter is used

- the +V is +11.5 VDC to +30 VDC, with a nominal value of +24 VDC.
- the maximum Ethernet cable run is 328 feet (100 meters).

7.2.2 Recommended Tools

The following tools may be needed for cabling the SM:

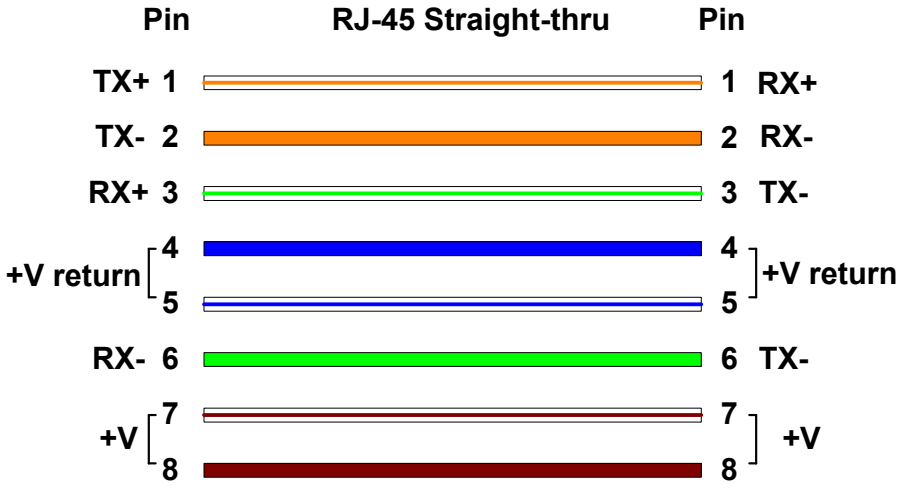
- RJ-45 crimping tool
- electrician scissors
- wire cutters
- cable testing device.

7.2.3 Connector Wiring

The following diagrams correlate pins to wire colors and illustrate crossovers where applicable.

RJ-45 Straight-thru Ethernet Cable

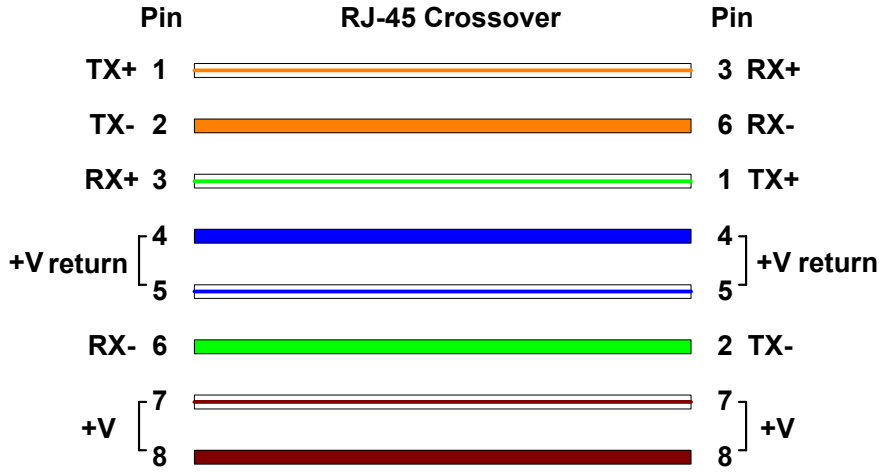
Pin 1 →	white / orange	← Pin 1
Pin 2 →	orange	← Pin 2
Pin 3 →	white / green	← Pin 3
Pin 4 →	blue	← Pin 4
Pin 5 →	white / blue	← Pin 5
Pin 6 →	green	← Pin 6
Pin 7 →	white / brown	← Pin 7
Pin 8 →	brown	← Pin 8



Pins 7 and 8 are used to carry power to the Canopy modules.

RJ-45 Crossover Ethernet Cable

Pin 1 →	white / orange	← Pin 3
Pin 2 →	orange	← Pin 6
Pin 3 →	white / green	← Pin 1
Pin 4 →	blue	← Pin 4
Pin 5 →	white / blue	← Pin 5
Pin 6 →	green	← Pin 2
Pin 7 →	white / brown	← Pin 7
Pin 8 →	brown	← Pin 8



Pins 7 and 8 are used to carry power to the Canopy modules.

7.2.4 Overriding IP Address and Password Setting

Canopy systems offer a plug that allows the operator to temporarily override some SM settings and thereby regain control of the module. This plug is needed for access to the module in any of the following cases:

- The operator has forgotten either
  - the IP address assigned to the module.
  - the password that provides access to the module.
- The module has been locked by the No Remote Access feature. (See Denying All Remote Access on Page 28 and Reinstating Remote Access Capability on Page 29.)
- Local access is desired for a module that has had the 802.3 link disabled in the Configuration page of the module.

This override plug resets the LAN 1 IP address to 169.254.1.1. The plug allows the operator to access the module through the default configuration *without changing* the configuration. The operator can then view and reset any non-default values.

Acquiring the Override Plug

The operator can either purchase or fabricate an override plug as follows. To purchase an override plug for a nominal fee, order the plug at http://www.best-tronics.com/motorola.

Procedure 8: Fabricating an override plug

To fabricate an override plug

1. Install an RJ-11 6-pin connector onto a 6-inch length of CAT 5 cable.
2. Pin out all 6-pins.
3. Short (solder together) Pins 4 and 6 on the other end. Do not connect any other wires to anything. The result should be as follows:

Pin 1 → white / orange	← Pin 1
Pin 2 → white / green	← Pin 2
Pin 3 → white / blue	← Pin 3
Pin 4 → green	← Pin 6
Pin 5 → blue	← Pin 5
Pin 6 → orange	← Pin 4

Using the Override Plug

The operator can regain access to the module as follows:

Procedure 9: Regaining access to the module

To use the override plug

1. Insert override plug into the RJ-11 GPS sync port of the module.
2. Apply power to the module through the Ethernet cable.

   RESULT: The module reboots with the default IP address of 169.254.1.1, password fields blank, and all other configuration values as previously set.
3. Set passwords as desired.
4. Change configuration values if desired.
5. Save the settings.
6. Remove the override plug.
7. Power cycle the module.

7.2.5 Wiring to Extend Network Sync

The following procedure can be used to extend network sync by one additional hop, as described under Synchronization on Page 18. Where a collocated module receives sync over the air, the collocated modules can be wired to pass the sync as follows:

Procedure 10: Extending network sync

1. Connect the GPS Sync ports of the collocated modules with RJ-11 cable.
2. Set the **Sync Input** parameter on the Configuration page of the collocated AP or BH timing master to **Sync to Received Signal (Timing Port)**.

3. Set the **Frame Timing Pulse Gated** parameter on the Configuration page of the collocated SM to **Enable**. See Frame Timing Pulse Gated on Page 89.

   NOTE: This setting prevents interference in the event that the SM loses sync.

7.3 CONFIGURING THE SM

To put configuration changes into effect in any case, the operator must:

1. Make the change(s) on the web page of the module.
2. Click the **Save** button to temporarily save the change(s).
3. Click the **Reboot** button to reboot the module and implement the change(s).

To configure the SM, the operator must manually set each parameter. (No Quick Start page is available.)

7.3.1 Configuration from the Factory

From the factory, the SM is configured to *not transmit* on any frequency. This configuration ensures that an operator does not accidentally turn on an unsynchronized SM.

Site synchronization of SMs is required because

- Canopy modules
  - transmit or receive, but not at the same time.
  - use TDD (Time Division Duplexing) to distribute signal access of the downlink and uplink frames.
- When one SM transmits while another receives signal, the transmitting module may interfere with or desense the receiving module. In this context, interference is self-interference (within the same Canopy network).

7.3.2 GUI Access Difficulty

Proxy settings in the web browser may prevent access to the Canopy GUI (graphical user interface). This can occur when the computer has used a proxy server address and port to configure a Canopy module. In this case, perform the following procedure to toggle the computer to not use the proxy setting.

GUI Access Procedure

Perform the following steps to access the GUI of this module:

Procedure 11: Bypassing proxy settings to gain access module web pages

1. Launch Microsoft Internet Explorer.
2. Select **Tools** → **Internet Options** → **Connections** → **LAN Settings**.
3. Uncheck the **Use a proxy server…** box.

NOTE: If an alternate web browser is used, the menu selections differ from the above.

7.3.3 Configuration Procedure

This procedure includes both required and optional settings.

Required Steps

Perform the following steps to configure the SM:

Procedure 12: Setting mandatory Configuration page parameters

1. Remove the base cover of the SM. (See Figure 29 on Page 69.)
2. In the powered down state, connect the Ethernet cable to the Ethernet port on both the SM and the computer.
3. Connect a power source to the SM.

   RESULT: When power is applied to a Canopy module or the unit is reset on the web-based interface, the module requires approximately 25 seconds to boot. During this interval, self-tests and other diagnostics are being performed. See Diagnostic LEDs on Page 70.
4. Assign an RF frequency for the module. See Custom RF Frequency Scan Selection List on Page 87.
5. Assign an IP address to the module for the target network, and assign an appropriate subnet mask and network gateway. See
   - LAN1 Network Interface Configuration, IP Address on Page 93.
   - LAN1 Network Interface Configuration, Subnet Mask on Page 93.
   - LAN1 Network Interface Configuration, Gateway IP Address on Page 93.
6. Configure the appropriate color code on the SM so that SM can register. See Color Code on Page 87.

Optional Steps

In addition, the operator can perform the following optional steps:

Procedure 13: Setting optional Configuration page parameters

1. Assign as many as several passwords to prevent unauthorized users from connecting to the web-based interface of the SM. From the factory, no default password is assigned and password protection is turned off.
   - Passwords can be from 1 to 16 characters. Any combination of characters is allowed, except for the following special characters:

     “ , . ‘ { } / \
     ; : [ ] ( ) ` ~

   - Either of two types of passwords can be configured: display-only or full-access.

     The display-only password allows the operator to view the current status of the module. The full-access password allows the operator to both view the current status and change the module configuration. The red lettering to the right of the entry fields indicates that a password is set, but does not allow the operator see the password.

For a description of interactions between settings of these types of passwords, see Display-Only Access on Page 88 and Full Access on Page 88.

NOTE: If the operator forgets either the password or the IP address for the module, a Canopy system override plug can be used to regain access. For details, see Overriding IP Address and Password Setting on Page 73.

2. Populate the **Site Name**, **Site Location**, and **Site Contact** fields. This is for only information purposes. See
   - Site Name on Page 91.
   - Site Contact on Page 91.
   - Site Location on Page 91.

7.4 INSTALLING THE SM

NOTE: When power is applied to a Canopy module or the unit is reset on the web-based interface, the module requires approximately 25 seconds to boot. During this interval, self-tests and other diagnostics are being performed.

To install the Canopy SM, perform the following steps:

Procedure 14: Installing the SM

1. Remove the base cover of the SM. (See Figure 29 on Page 69.)
2. In the powered down state, attach the cables to the SM. (See Cabling the SM on Page 70 and Figure 30 on Page 77.)

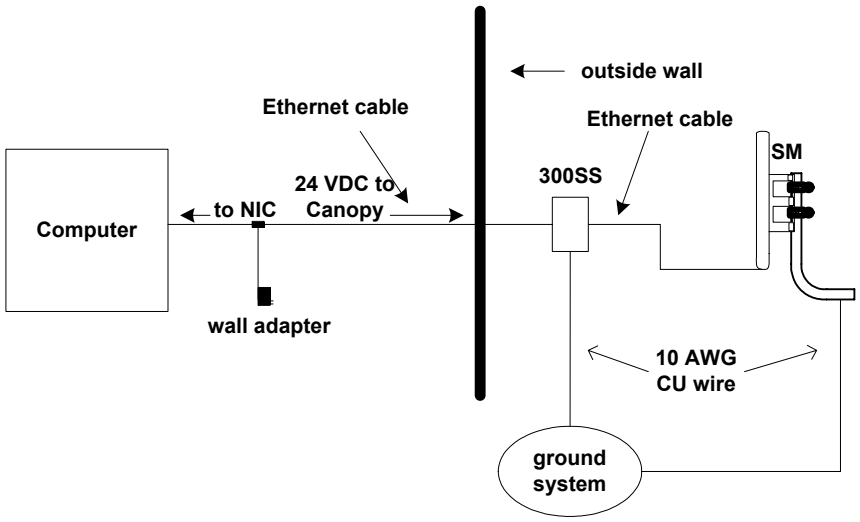


Figure 30: SM and computer wiring

3. Choose the best mounting location for your particular application.
4. Optionally, attach the SM to the arm of the Canopy Passive Reflector dish assembly as shown in Figure 31.

NOTE: The arm is molded to receive and properly aim the module relative to the aim of the dish. Use stainless steel hose clamps for the attachment.

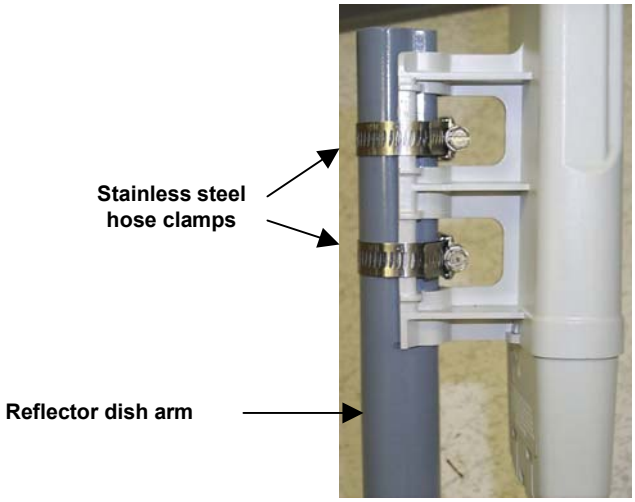


Figure 31: SM attachment to reflector arm

5. Use stainless steel hose clamps or equivalent fasteners to lock the SM into position.
6. Connect the module to an Ethernet/Power port on the computer.
7. Unlock the module from the locked down state.
8. On the computer, access the Alignment page of this module.
9. In the **RF Carrier Frequency** field, select the frequency that the AP transmits.
10. In the **RSSI Only Mode** field, ensure that the **Disabled** button is selected.
11. For coarse alignment of the SM, either
    a. use the LEDs in the module as follows:
       (1) On the computer, click **Enable Aiming Mode**.

           NOTE: This places the module into the Normal Aiming Mode. The module is automatically placed into the Operating Mode after 15 minutes. To return the module to the Operating Mode before this interval has expired, click **Disable Aiming Mode**. To return the module to an aiming mode after this interval has expired, click **Enable Aiming Mode**.

       (2) At the module, observe the six status LEDs in the module. See Figure 29 on Page 69.

       (3) Move the module slightly in the vertical plane until the largest number of LEDs is lit. See Table 11 on Page 70.

    b. use the Audible Alignment Tone feature (Release 4.0 and later) as follows:
       (1) On the computer, click **Disable Aiming Mode**.

       (2) Connect the cable from the Canopy Alignment Tool Headset kit to the RJ-11 port of the SM.

       (3) Connect the Alignment Tool Headset, and earpiece, or a small battery-powered speaker to this RJ-11 cable.

(4) Listen to the alignment tone for

- pitch, which indicates greater RSSI by higher pitch.
- volume, which indicates less jitter by higher volume.
- cadence, which indicates registration to the AP by a tone interruption of 0.155 seconds of quiet in each 2-second interval.

In Adobe Reader® 6.0 or later release, to hear an example of the alignment tone as the SM aligns and registers, click on the picture in Figure 32.

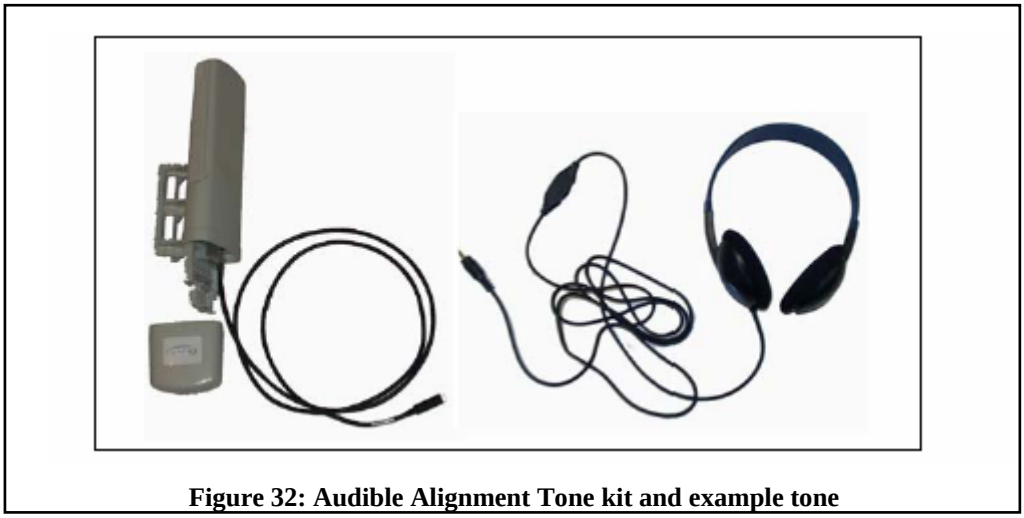


Figure 32: Audible Alignment Tone kit and example tone

(5) Move the module slightly until you hear the highest pitch and highest volume.

(6) Continue to move the module slightly until you hear the tone interruptions, if possible.

12. On the computer, in the **RSSI Only Mode** field, click **Enabled**.
13. Click **Enable Aiming Mode**.
14. Simultaneously, begin to
    - move the module slightly in the vertical plane.
    - on the computer, click **Enable Aiming Mode** frequently to refresh the page as the module moves (or select the auto-refresh option for this web page).
    - monitor the screen for a simultaneous RSSI level of greater than 700, jitter value between 0 and 4 in Release 4.0 and later releases or between 5 and 9 in any earlier release, and efficiencies greater than 90% for both the uplink and the downlink.
15. When the RSSI level is greater than 700, stop the movement of the module and click **Disable** in the **RSSI Only Mode** field.
16. Access the Status page.

17. Monitor this page for the messages **Scanning**, **Syncing**, **Registering**, **Registered**, **Alignment**.

    NOTE: If the SM does not register with the AP, ensure that both modules are configured to the same color code in the Configuration page of each. In Release 4.0 and later releases, the Expanded Stats page of the AP provides a link to the Reg Failed SMs page, where the cause of a registration failure may be found.

18. Resume slight movements of the module
19. When the best achievable values are simultaneously displayed on the Status page, lock the module into position.

    NOTE: If any of these values is not achieved, the SM may be operational but manifest occasional problems.

7.5 VERIFYING SYSTEM PERFORMANCE

To verify the performance of the Canopy system after the SMs have been installed, perform the following steps:

Procedure 15: Verifying system performance

1. Access the web-based interface for the AP (by opening http://<ip-address>, where the <*ip-address*> is the address of the individual module).
2. In the menu on the left-hand side of the web page, click on **GPS Status**.
3. Verify in the **Satellites Tracked** field that the AP is seeing and tracking satellites. (To generate the timing pulse, the module must track at least 4 satellites.)
4. Verify that the **Antenna Status** field displays the value OK.
5. Access the Status Page of the SM.
6. Verify that the SM is still registered to the AP.
7. Access the Configuration page of the SM.
8. Note the frequency that is selected in the **Custom RF Frequency Scan Selection List** field.
9. Access the Configuration page of the AP.
10. Verify that the frequency that is selected in the **RF Frequency Carrier** field is the same as noted above.
11. Access the AP Eval Data page of the SM.
12. Verify that the AP is shown in the **Sector ID** field.

8 SM INTERFACE PAGES

The Canopy SM interface provides a series of web pages to configure and monitor the unit. The following is a quick reference to the interface screens.

NOTE: These screens are subject to change by subsequent software versions.

Access to the web-based interface is available only through a computer that is directly connected or connected through a network to the SM. If the computer is not connected to a network when the module is configured on a bench, then disabling of the proxy setting in the computer may be required. In the address bar of the browser, the operator enters the IP address of the SM (default is 169.254.1.1).

The interface of the SM provides access to the following pages:

Status
Configuration
IP Configuration
NAT Configuration
Event Log
AP Eval Data
Ethernet Stats
Expanded Stats

These pages resemble those of the BH timing slave, but differ and are unique to the SM.

8.1 STATUS PAGE

Examples of a Status screens are displayed in Figure 33 and Figure 34.

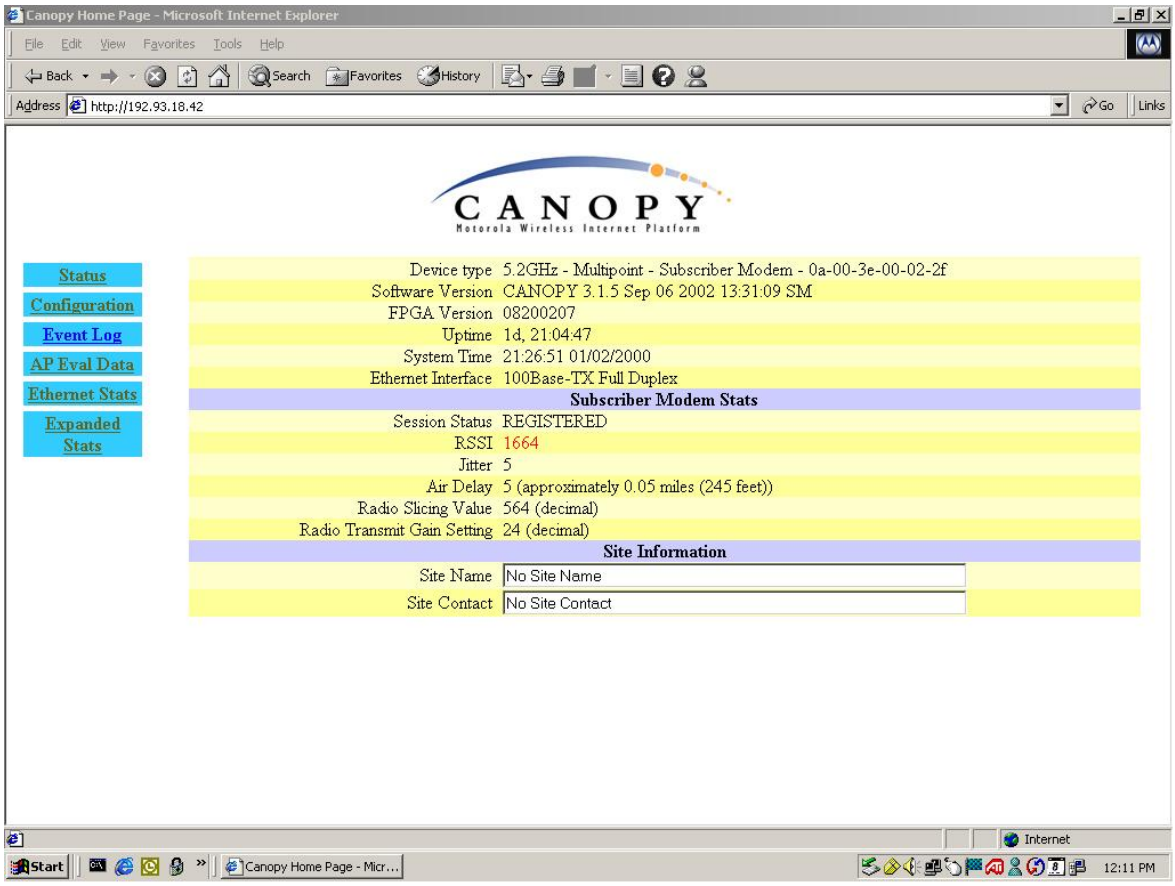


Figure 33: Status screen for 5.2-GHz SM

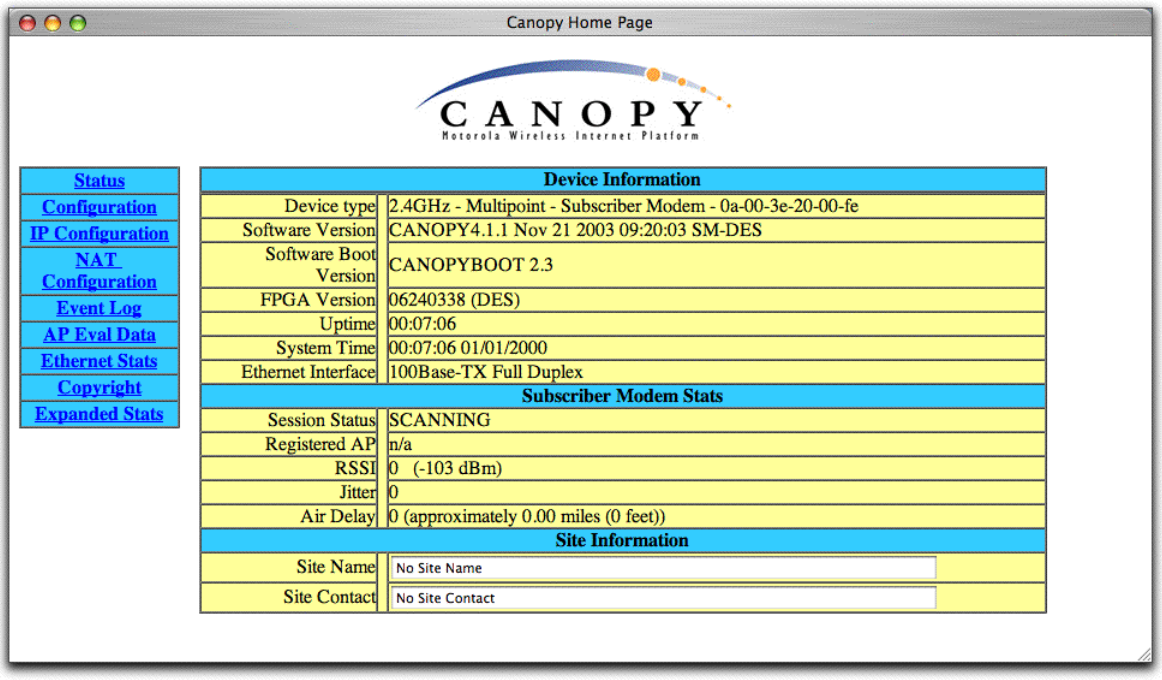


Figure 34: Status screen for 2.4-GHz SM

The Status page provides information on the operation of this SM. This is the default web page for the SM.

8.1.1 Status Parameters

The Status page provides the following parameters:

Device Type

This field indicates the type of the Canopy module. Values include the frequency band of the module, the protocol that is used, and the MAC address of the module.

Canopy Boot Version

This field indicates the version of the software that is operated on the module, the date and time of boot, and whether the module is secured by DES or AES encryption (see Security Features on Page 21). When requesting technical support, provide the information from this field.

FPGA Version

This field indicates the version of the field-programmable gate array (FPGA) on the module. When requesting technical support, provide the information from this field.

Uptime

This field indicates how long the module has operated since power was applied.

System Time

This field provides the current time. Any SM that registers to an AP inherits the system time, which is displayed in this field as GMT (Greenwich Mean Time).

Ethernet Interface

This field indicates the configuration of the Ethernet interface on the module.

Session Status

This field displays the following information about the current session:

- **Scanning** indicates that this SM currently cycles through the RF frequencies that are selected in the Configuration page. (See Custom RF Frequency Scan Selection List on Page 87.
- **Syncing** indicates that this SM currently attempts to receive sync.
- **Registering** indicates that this SM has sent a registration request message to the AP and has not yet received a response.
- **Registered** indicates that this SM is both
  - registered to an AP.
  - ready to transmit and receive data packets.
- **Alignment** indicates that this SM is in an aiming mode. See
  - Table 11 on Page 70.
  - Alignment Page on Page 111.

Registered AP

This field displays the IP address of the AP to which this SM is registered.

RSSI

This field displays the current RSSI (Radio Signal Strength Indicator) if the module is registered to an AP. An acceptable link has an RSSI of greater than 700. However, to achieve the best link possible, the alignment of the module should balance good RSSI values against good jitter values.

> ***NOTE:*** Unless the page is set to auto-refresh, the value displayed is the RSSI value at the instant the Status page was called. To keep a current view of the RSSI, the browser screen must be refreshed or the page must be set to auto-refresh.

Jitter

This field displays the quality of the currently received signal if the module is registered to an AP. An acceptable link has a jitter value between 0 and 4 in Release 4.0 and later releases or between 5 and 9 in any earlier release.

However, to achieve the best link possible, the alignment of the module should balance good jitter values against good RSSI values.

> ***NOTE:*** Unless the page is set to auto-refresh, the value displayed is the jitter value at the instant the Status page was called. To keep a current view of the jitter, the browser screen must be refreshed or the page must be set to auto-refresh.

Air Delay

This field displays the distance in feet between this SM and the AP. To derive the distance in meters, the operator should multiply the value of this parameter by 0.3048. Distances reported as less than 200 feet (61 meters) are unreliable.

Site Name

This field indicates the name of the physical module. The operator can assign or change this name on the Configuration web page. This information is also set into the *sysName* SNMP MIB-II object and can be polled by an SNMP management server.

Site Contact

This field indicates contact information for the physical module. The operator can provide or change this information on the Configuration web page. This information is also set into the *sysName* SNMP MIB-II object and can be polled by an SNMP management server.

8.2 CONFIGURATION PAGE

Examples of Configuration screens are displayed in Figure 35 and Figure 36.

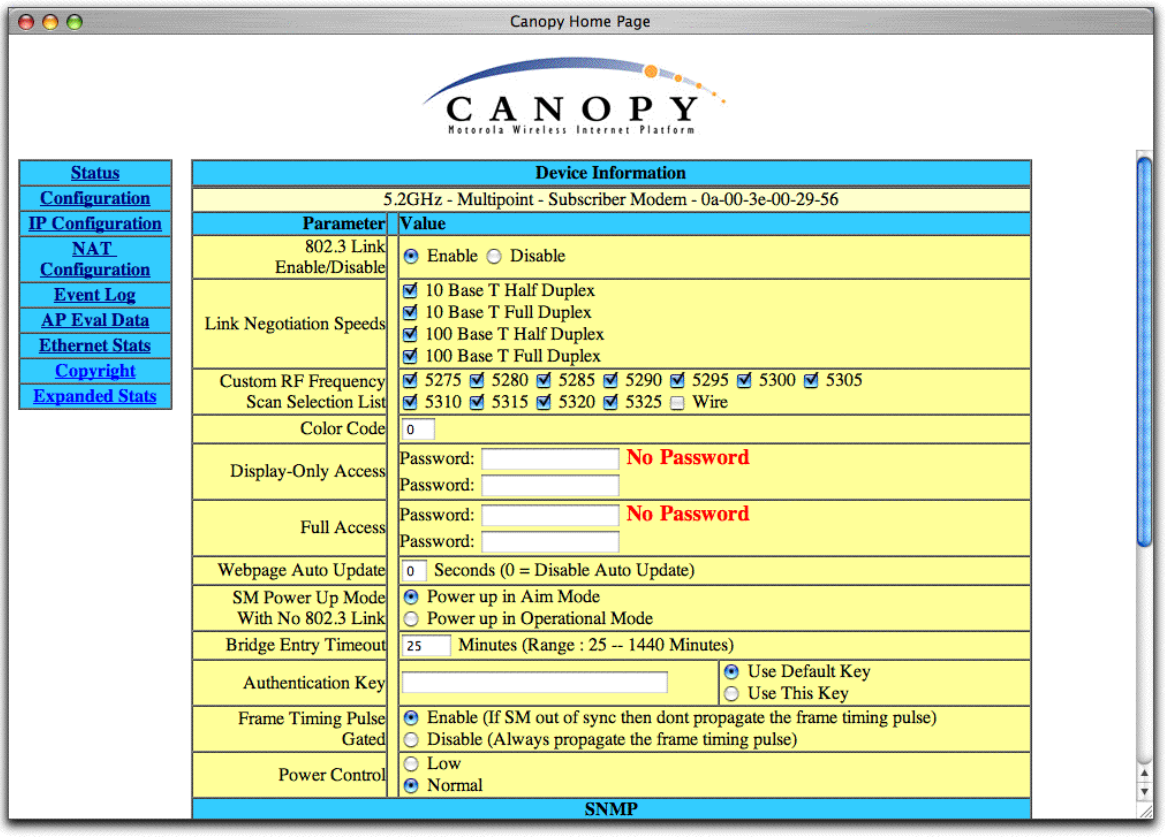


Figure 35: Configuration screen for 5.2-GHz SM

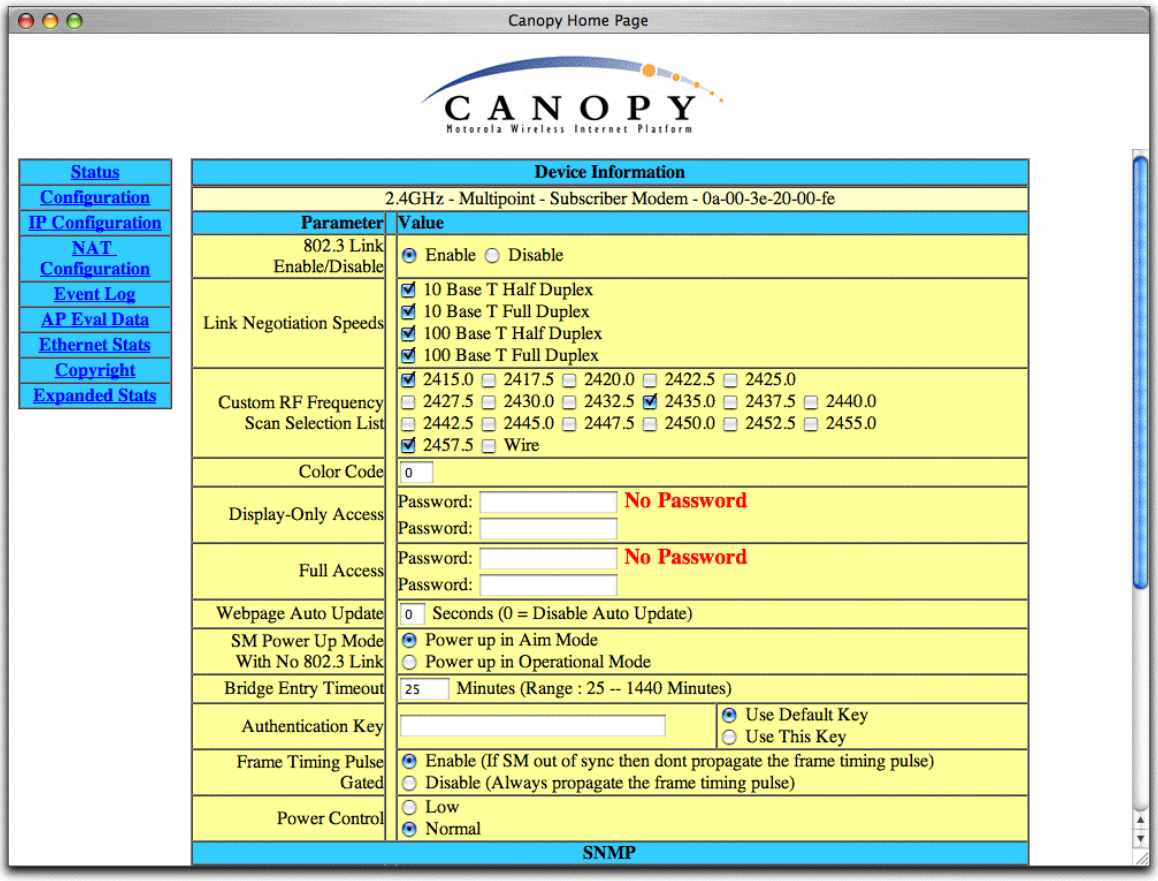


Figure 36: Configuration screen for 2.4-GHz SM

The Configuration web page contains all of the configurable parameters that define how the module operates. The first line of information on the Configuration screen echoes the **Device Type** from the Status web page.

8.2.1 Configuration Parameters

As shown in Figure 35, the Configuration page provides the following parameters:

802.3 Link Enable/Disable

The operator specifies whether to not allow the SM to send and receive data through the Ethernet port even when the RF link to the AP is active. This field toggles on or off the Browser-based Disabling of Subscriber Module Ethernet Interface feature in Release 3.2 and later releases. The operator can alternatively control this feature from the AP.

When enabled, this feature

- disallows the SM user to access the link, as in the case where the user account is delinquent.
- allows the operator to partition the network for troubleshooting or another analytical or operation function.

The operator selects either

- **Enable** to activate this feature.
- **Disable** to deactivate this feature.

Link Negotiation Speeds

The operator specifies the type of link speed desired for the Ethernet connection. The default for this parameter is that all speeds are selected. The recommended setting is a single speed selection for all APs, BHs, and SMs in the operator network.

Custom RF Frequency Scan Selection List

The operator specifies the frequency that the SM scans to find the access point. The frequency *band* of the SM affects what channels the operator selects.

In the 2.4-GHz frequency band, the SM can register to an AP that transmits on a frequency 2.5 MHz higher than the frequency that the SM receiver locks when the scan terminates as successful. This establishes a poor-quality link. To prevent this, the operator should select frequencies that are at least 5 MHz apart.

In a 2.4-GHz SM, this field displays all available channels, but has only three recommended channels selected by default. See 2.4-GHz AP Cluster Recommended Channels on Page 61.

In a 5.2-GHz SM, this field displays only ISM frequencies. In a 5.7-GHz SM, this field displays both ISM and U-NII frequencies. If the operator selects all frequencies that are listed in this field (default selections), then the SM scans for a signal on any channel. If the operator selects only one, then the SM limits the scan to that channel. Since the frequencies that this field offers for each of these two bands are 5 MHz apart, a scan of *all* channels does not risk establishment of a poor-quality link as in the 2.4-GHz band.

A list of channels in the band is provided in one of the following sections:

- 2.4-GHz Channels on Page 60.
- 5.2-GHz Channels on Page 60.
- 5.7-GHz Channels on Page 62.

(The selection labeled **Factory** requires a special software key file for implementation.)

Color Code

The operator specifies a value from 0 to 254. For registration to occur, the color codes of the SM and of the AP *must* match. Color code is not a security feature. Color code allows the operator to segregate an individual network or neighbor Canopy networks.

Color code also allows the operator to force an SM to register to only a specific AP, even if the SM can reach multiple APs. On all Canopy modules, the default setting for the color code value is 0. This value matches only the color code of 0 (*not* all 255 color codes).

Display-Only Access

The operator enters the same password in both **Display-Only Access** fields for verification. When used, the display-only password allows only viewing activities on the module.

This protection interacts with the **Full Access** password protection as follows:

- If the display-only password is set and the **Full Access** password *is not*, then:
  - The display-only password is tied to telnet and FTP sessions to the module.
  - Anyone who enters the display-only password can view *or change* activities. This configuration *is not* recommended.
- If the **Full Access** password is also set, then the **Full Access** password is tied to telnet and FTP sessions.
- If the display-only password *is not* set and the **Full Access** password is, then no password is required to view activities on the module.
- If neither password is set, then anyone can view or change activities. This configuration *is not* recommended.

If the operator-assigned **Display-Only Access** password is forgotten, then the operator must both:

1. physically access the module.
2. use an override plug to electronically access the module configuration parameters at 169.254.1.1. See Overriding IP Address and Password Setting on Page 73.

Full Access

The operator enters the same **Full Access** password in both fields for verification. When used, the **Full Access** password

- allows both viewing and change activities on the module.
- is tied to telnet and FTP sessions to the module.

When the web-based interface prompts for this password, no user name is required. However, when a telnet or FTP session prompts for this password, the user name `root` must be entered in addition to the password.

If the operator-assigned **Full Access** password is forgotten, then the operator must both

1. physically access the module.
2. use an override plug to electronically access the module configuration parameters at 169.254.1.1. See Overriding IP Address and Password Setting on Page 73.

NOTE: The operator can unset either password (revert the access to no password required). To do so, the operator types a space into the field and reboots the module. Any password must be entered twice to allow the system to verify that that the password is not mistyped. After any password is set and a reboot of the module has occurred, a **Password Set** indicator appears to the right of the field.

Webpage Auto Update

The operator enters the frequency (in seconds) for the web browser to automatically refresh the web-based interface. The default setting is 0. The 0 setting causes the web-based interface to never be automatically refreshed.

SM Power Up Mode With No 802.3 Link

The operator specifies the default mode in which this SM will power up when the module senses no Ethernet link. The operator selects either

- **Power Up in Aim Mode**—the module boots in an aiming mode. (See Table 11 on Page 70 and Alignment Page on Page 111.) When the module senses an Ethernet link, this field is automatically reset to Power Up in Operational Mode. When the module senses no Ethernet link within 15 minutes after power up, the module carrier shuts off.
- **Power Up in Operational Mode**—the module boots in Operational mode. The module attempts registration. This is the default selection.

Bridge Entry Timeout

The operator specifies the appropriate bridge timeout for correct network operation with the existing network infrastructure. Timeout occurs when the AP encounters no activity with the SM (whose MAC address is the bridge entry) within the interval that this field specifies. The Bridge Entry Timeout should be a longer period than the ARP (Address Resolution Protocol) cache timeout of the router that feeds the network.

This field governs the timeout interval, even if a router in the system has a longer timeout interval. The default value of this field is 25 minutes.

An inappropriately low Bridge Entry Timeout setting may lead to temporary loss of communication with the other module.

Authentication Key

The operator specifies the type of encryption. This field is used only if authentication is required by the AP:

- **Use Default Key** specifies the predetermined key for authentication in the BAM server. See Bandwidth and Authentication Manager (BAM) on Page 22.
- **Use This Key** specifies the hexadecimal key that is permanently stored on the SM.

Frame Timing Pulse Gated

If this SM extends the sync pulse to a BH master or an AP, then the operator selects either

- **Enable**—If this SM loses sync from the AP, then *do not* propagate a sync pulse to the BH timing master or other AP.
- **Disable**— If this SM loses sync from the AP, then propagate the sync pulse to the BH timing master or other AP.

See Wiring to Extend Network Sync on Page 74.

NOTE: This setting prevents interference in the event that the SM loses sync.

Power Control

In Release 4.1 and later releases, the operator selects either

- **Low** to set the SM to operate at 18 dB less than full power to reduce the possibility of self-interference with a nearby module.
- **Normal** to allow the SM to operate at full power.

Selection of **Low** can cause the SM to drop an active RF link to a module that is relatively far from the low-power SM. If a link is dropped when Power Control is set to **Low**, the link can be re-established by only Ethernet access.

See Power Reduction to Mitigate Interference on Page 59.

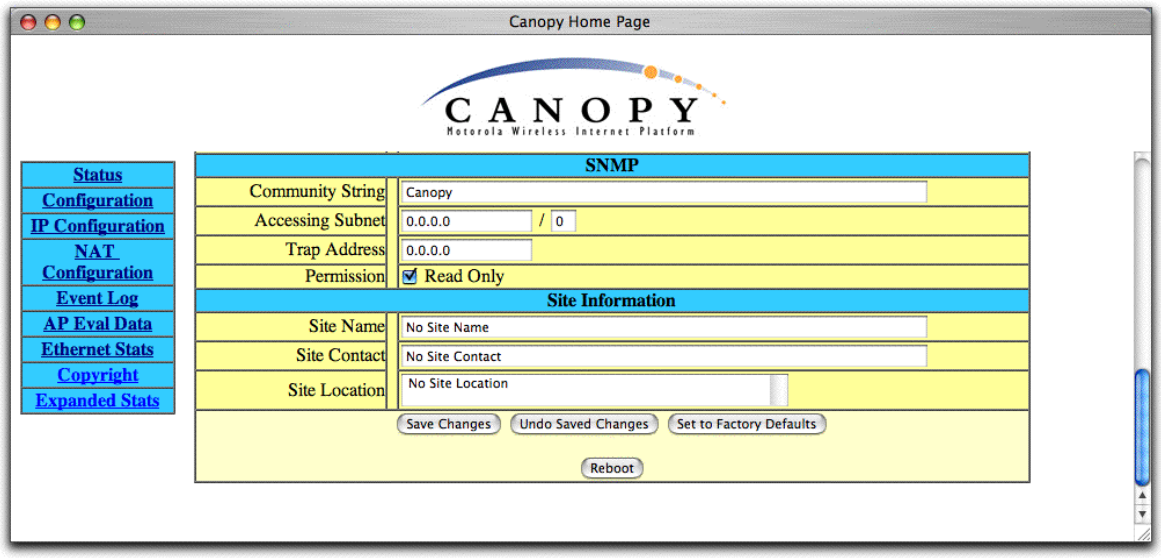


Figure 37: Configuration screen, continued

As shown in Figure 37, the Configuration page continues with the following parameters:

Community String

The operator specifies a control string that allows an SNMP NMS (network management system) to access MIB information about this SM. No spaces are allowed in this string. The default string is **Canopy**.

Accessing Subnet

The operator specifies the NMS server that is allowed to access MIB information from the module. The following two types of information must be entered:

- The network IP address in the form xxx.xxx.xxx.xxx
- The CIDR (Classless Interdomain Routing) prefix length in the form /xx (for example, 198.32.0.0/16 where /16 is a subnet mask of 255.255.0.0).

  NOTE: For more information on CIDR, execute an Internet search on “Classless Interdomain Routing.”

The default treatment is to allow all networks access (set to 0).

Trap Address

The operator specifies the IP address (xxx.xxx.xxx.xxx) of an NMS server to which trap information should be sent. Trap information informs the monitoring system that something has occurred. For example, trap information is sent:

- after a reboot of the module.
- when an NMS server attempts to access agent information but either
  - supplied an inappropriate community string or SNMP version number.
  - is associated with a subnet to which access is disallowed.

Permission

The operator can set this parameter to **Read Only** to disallow any parameter changes by the NMS.

Site Name

The operator specifies a string to associate with the physical module. This parameter is written into the *sysName* SNMP MIB-II object and can be polled by an SNMP management server. The buffer size for this field is 128 characters.

Site Contact

The operator enters contact information for the module administrator. This parameter is written into the *sysContact* SNMP MIB-II object and can be polled by an SNMP management server. The buffer size for this field is 128 characters.

Site Location

The operator enters information about the physical location of the module. This parameter is written into the *sysLocation* SNMP MIB-II object and can be polled by an SNMP management server. The buffer size for this field is 128 characters.

8.2.2 Configuration Buttons

The Configuration page provides the following buttons:

Save Changes

When the operator clicks this button, any changes that have been made on the Configuration page are recorded in flash memory. However, these changes *do not* apply until the next reboot of the module.

Undo Saved Changes

When the operator clicks this button, any changes that have been made but were not committed by a reboot of the module are undone.

Set to Factory Defaults

When the operator clicks this button, all configurable parameters are reset to the factory settings.

Reboot

When the operator clicks this button, the module reboots. When the operator has changed parameters in the Configuration page, the system highlights the **Reboot** button as a reminder that a reboot (in addition to a save operation) is required to implement the changes.

8.3 IP CONFIGURATION PAGE

An example of an IP Configuration screen is displayed in

- Figure 38 on Page 92 for the NAT Disabled implementation with public accessibility.
- Figure 39 on Page 93 for the NAT Disabled implementation with local accessibility.
- Figure 40 on Page 94 for the NAT with DHCP Client and DHCP Server implementation.
- Figure 41 on Page 95 for the NAT with DHCP Client implementation.
- Figure 42 on Page 96 for the NAT with DHCP Server implementation.
- Figure 43 on Page 97 for the NAT without DHCP implementation.

The set of parameters that the IP Configuration page provides depends on whether network address translation is enabled.

8.3.1 IP Configuration Parameters with NAT Disabled

When NAT (network address translation) is disabled on the NAT Configuration page as shown in Figure 44 on Page 99, the IP Configuration page provides the following parameters:

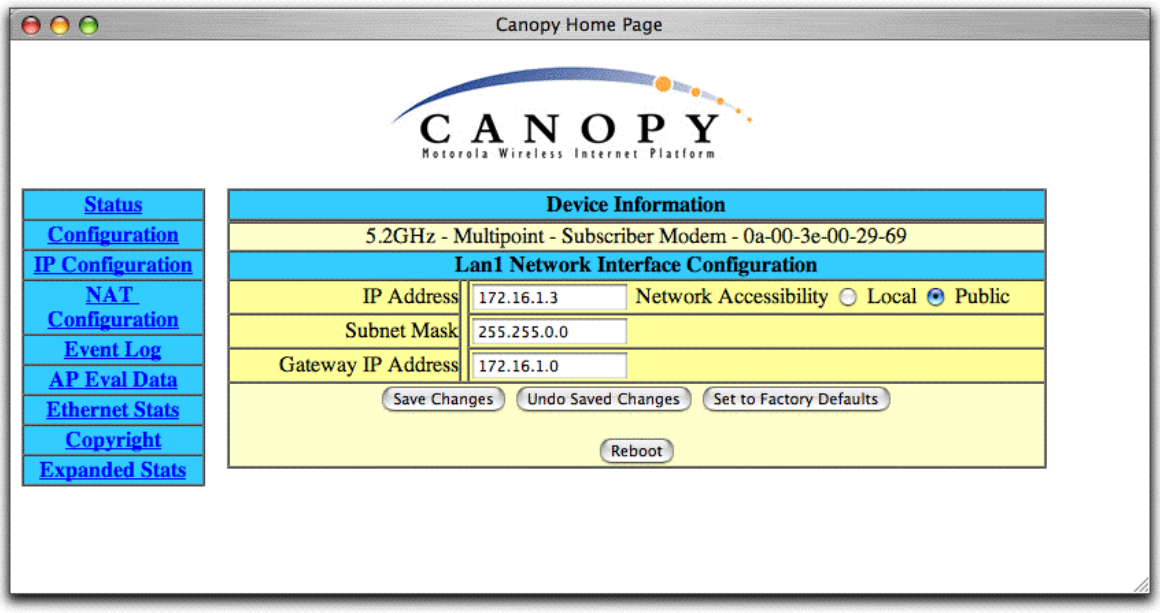


Figure 38: IP Configuration screen, NAT disabled, public accessibility

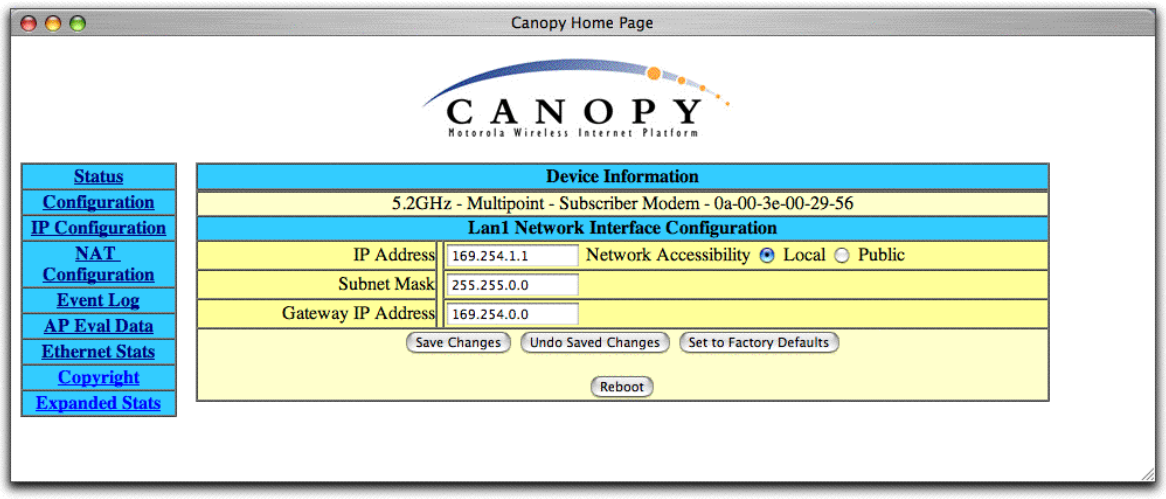


Figure 39: IP Configuration screen, NAT disabled, local accessibility

LAN1 Network Interface Configuration, IP Address

The operator enters the *non-routable* IP address that will be associated with the Ethernet connection on this module. (The default IP address from the factory is 169.254.1.1.) If the operator-assigned IP address is forgotten, then the operator must both

1. physically access the module.
2. use an override plug to electronically access the module configuration parameters at 169.254.1.1. See Overriding IP Address and Password Setting on Page 73.

LAN1 Network Interface Configuration, Subnet Mask

The operator enters an appropriate subnet mask for the module to communicate on the network. The default subnet mask is 255.255.255.0. See General IP Addressing Concepts on Page 66.

LAN1 Network Interface Configuration, Gateway IP Address

The operator enters the appropriate gateway for the module to communicate with the network. The default gateway is 169.254.0.0. See SM Module Address Assignment on Page 68.

8.3.2 IP Configuration Buttons with NAT Disabled

Regardless of whether NAT is enabled, the IP Configuration page provides the following buttons:

Save Changes

When the operator clicks this button, any changes that have been made on the IP Configuration page are recorded in flash memory. However, these changes *do not* apply until the next reboot of the module.

Undo Saved Changes

When the operator clicks this button, any changes that have been made but were not committed by a reboot of the module are undone.

Set to Factory Defaults

When the operator clicks this button, all configurable parameters are reset to the factory settings.

Reboot

When the operator clicks this button, the module reboots. When the operator has changed parameters in the IP Configuration page, the system highlights the **Reboot** button as a reminder that a reboot (in addition to a save operation) is required to implement the changes.

8.3.3 IP Configuration Parameters with NAT Enabled

When NAT (network address translation) is enabled, the IP Configuration page provides the following parameters:

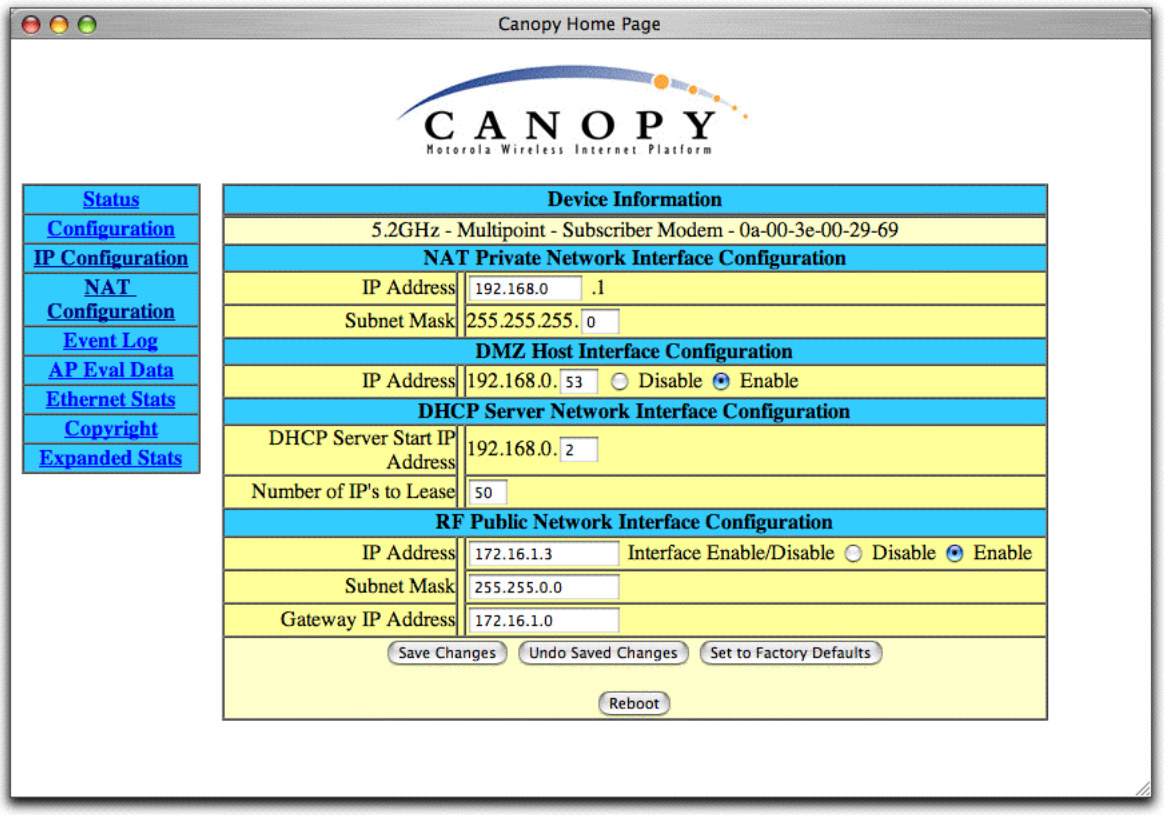


Figure 40: IP Configuration screen, NAT with DHCP client and DHCP server

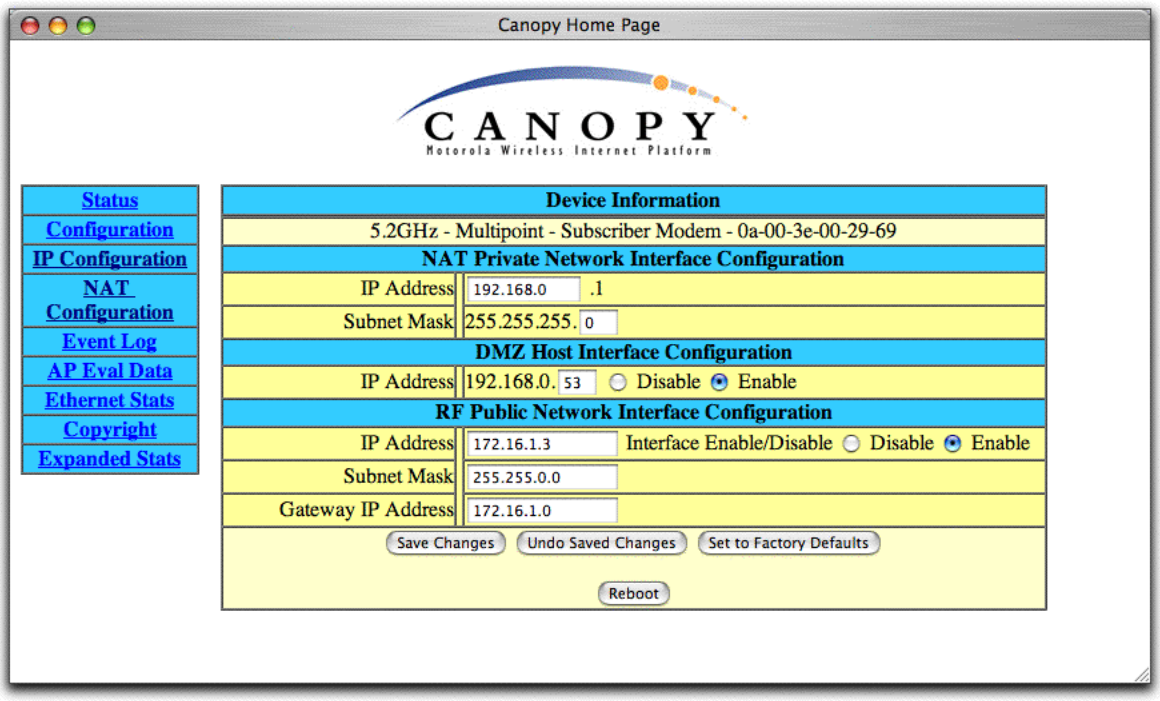


Figure 41: IP Configuration screen, NAT with DHCP client

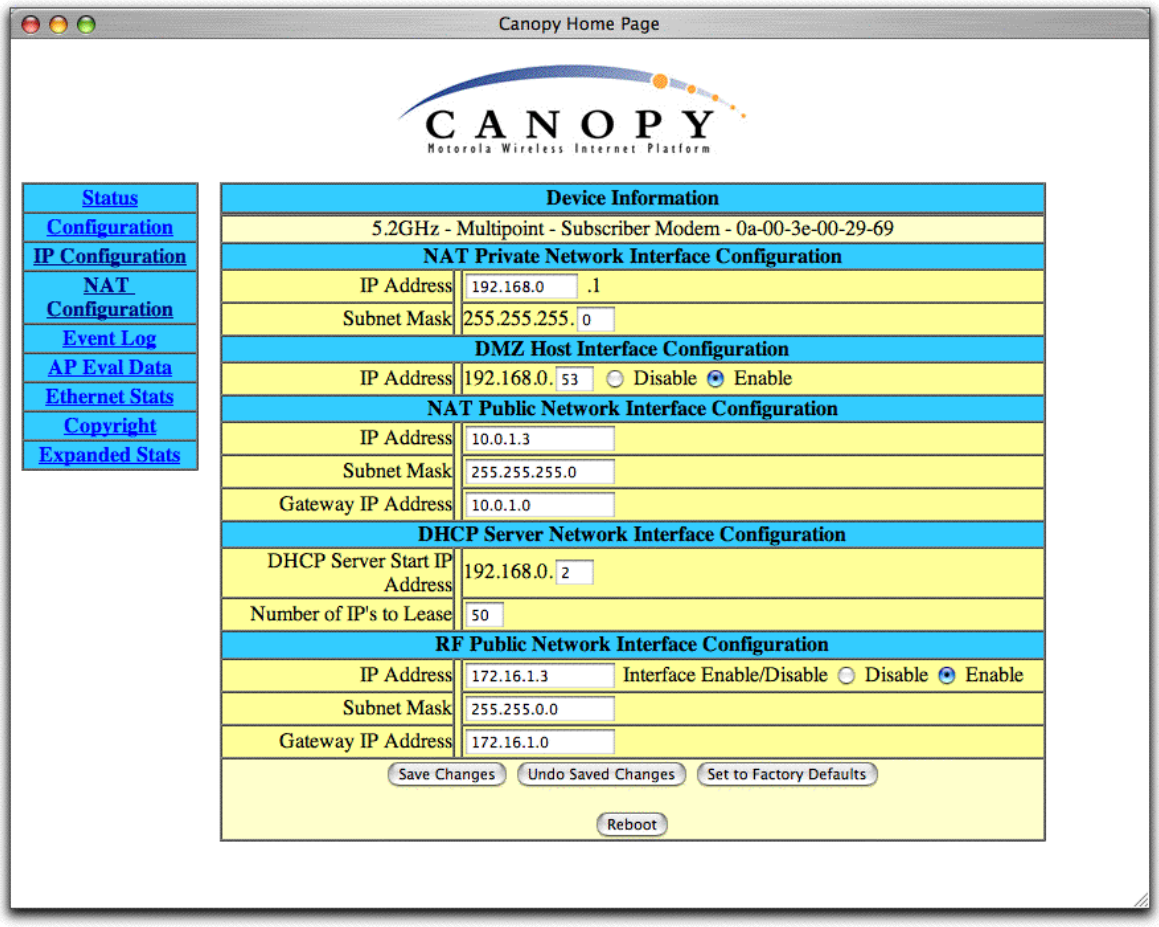


Figure 42: IP Configuration screen, NAT with DHCP server

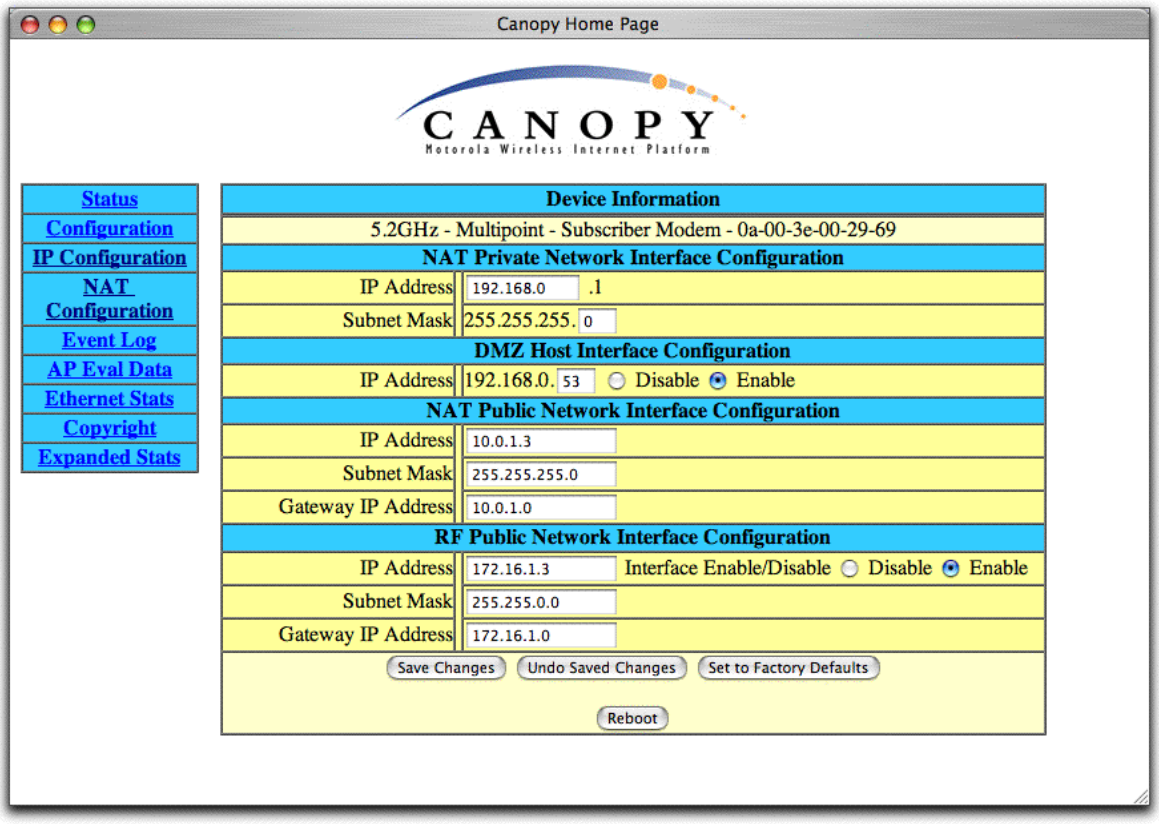


Figure 43: IP Configuration screen, NAT without DHCP

NAT Private Network Interface Configuration, IP Address

The operator assigns an IP address for module management. This address is available from only Ethernet access to the SM. The last characters of this address must be .1. This address becomes the base for the range of DHCP-assigned addresses.

NAT Private Network Interface Configuration, Subnet Mask

The operator assigns a subnet mask of 255.255.255.0 or a more restrictive subnet mask.

DMZ Host Interface Configuration, IP Address

The operator either enables or disables DMZ for this SM. See DMZ on Page 46.

Additionally, the operator assigns the DMZ IP address to be used for this SM when DMZ is enabled. The first three octets of this address are automatically set as identical to the first three octets of the address assigned in the **NAT Private Network Interface Configuration, IP Address** field above. Only one such address is allowed.

Behind this SM, the device that should receive network traffic must be assigned this address. The system provides a warning if the operator enters an address within the range that DHCP can assign.

NAT Public Network Interface Configuration, IP Address

This field displays the IP address of the SM. If DHCP Client is enabled, then the DHCP server automatically assigns this address.

NAT Public Network Interface Configuration, Subnet Mask

This field displays the subnet mask of the SM. If DHCP Client is enabled, then the DHCP server automatically assigns this subnet mask.

NAT Public Network Interface Configuration, Gateway IP Address

This field displays the gateway IP address for the SM. If DHCP Client is enabled, then the DHCP server automatically assigns this gateway IP address.

RF Public Network Interface Configuration, IP Address

The operator either enables or disables the RF public interface for this SM. Additionally, the operator assigns the IP address for over-the-air management of the module when the RF public interface is enabled.

RF Public Network Interface Configuration, Subnet Mask

The operator assigns the subnet mask for over-the-air management of the module when the RF public interface is enabled.

RF Public Network Interface Configuration, Gateway IP Address

The operator assigns the gateway IP address for over-the-air management of the module when the RF public interface is enabled.

8.3.4 IP Configuration Buttons with NAT Enabled

Regardless of whether NAT is enabled, the IP Configuration page provides the following buttons:

Save Changes

When the operator clicks this button, any changes that have been made on the IP Configuration page are recorded in flash memory. However, these changes *do not* apply until the next reboot of the module.

Undo Saved Changes

When the operator clicks this button, any changes that have been made but were not committed by a reboot of the module are undone.

Set to Factory Defaults

When the operator clicks this button, all configurable parameters are reset to the factory settings.

Reboot

When the operator clicks this button, the module reboots. When the operator has changed parameters in the IP Configuration page, the system highlights the **Reboot** button as a reminder that a reboot (in addition to a save operation) is required to implement the changes.

8.4 NAT CONFIGURATION PAGE

An example of an NAT Configuration screen is displayed in

- Figure 44 on Page 99 for the NAT Disabled implementation.
- Figure 45 on Page 101 for the NAT with DHCP Client and DHCP Server implementation.
- Figure 46 on Page 102 for the NAT with DHCP Client implementation.
- Figure 47 on Page 103 for the NAT with DHCP Server implementation.
- Figure 48 on Page 104 for the NAT without DHCP implementation.

The set of parameters that the NAT Configuration page provides depends on whether NAT (network address translation) is enabled. The default state of this page is with NAT disabled.

8.4.1 NAT Configuration Parameters with NAT Disabled

When NAT (network address translation) is disabled, the NAT Configuration page provides the following parameters:

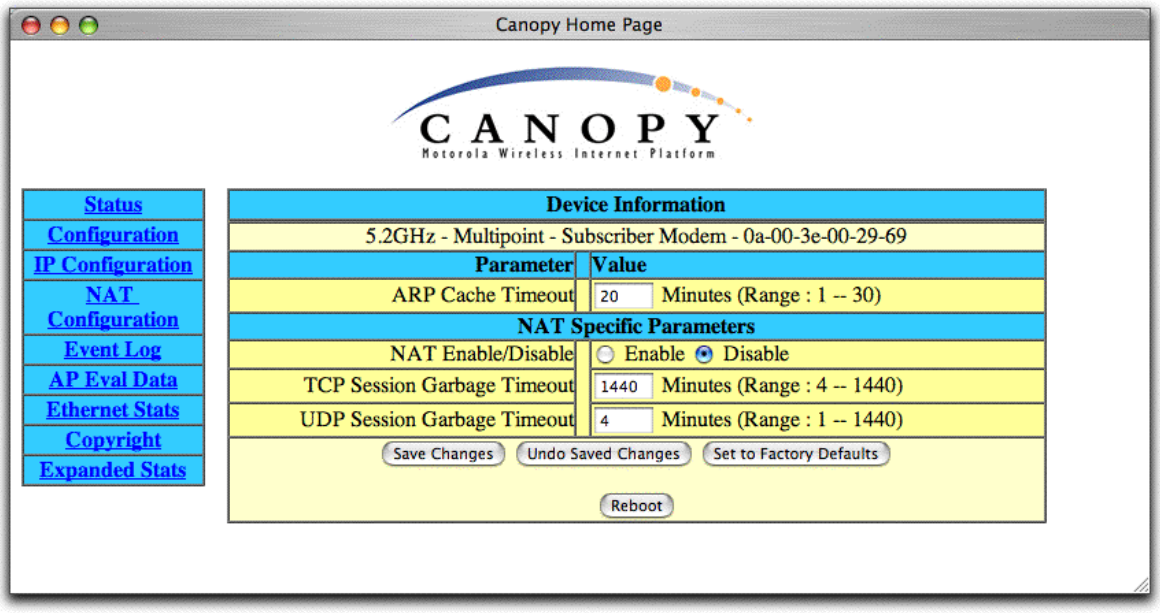


Figure 44: NAT Configuration screen, NAT disabled

ARP Cache Timeout

If a router upstream has an ARP cache of longer duration (as some use 30 minutes), then the operator enters a value of longer duration than the router ARP cache. The default value of this field is 20 seconds.

NAT Enable/Disable

The operator either disables NAT, or enables NAT to view additional options.

TCP Session Garbage Timeout

Where a large network exists behind the SM, the operator can set this value to lower than the default value of 1440 minutes (24 hours). This action makes additional resources available for greater traffic than the default value accommodates.

UDP Session Garbage Timeout

The operator may adjust this value in the range of 1 to 1440 minutes, based on network performance. The default value of this parameter is 4 minutes.

8.4.2 NAT Configuration Buttons with NAT Disabled

Regardless of whether NAT is enabled, the NAT Configuration page provides the following buttons:

Save Changes

When the operator clicks this button, any changes that have been made on the NAT Configuration page are recorded in flash memory. However, these changes *do not* apply until the next reboot of the module.

Undo Saved Changes

When the operator clicks this button, any changes that have been made but were not committed by a reboot of the module are undone.

Set to Factory Defaults

When the operator clicks this button, all configurable parameters are reset to the factory settings.

Reboot

When the operator clicks this button, the module reboots. When the operator has changed parameters in the NAT Configuration page, the system highlights the **Reboot** button as a reminder that a reboot (in addition to a save operation) is required to implement the changes.

8.4.3 NAT Configuration Parameters with NAT Enabled

When NAT (network address translation) is enabled, the NAT Configuration page provides the following parameters:

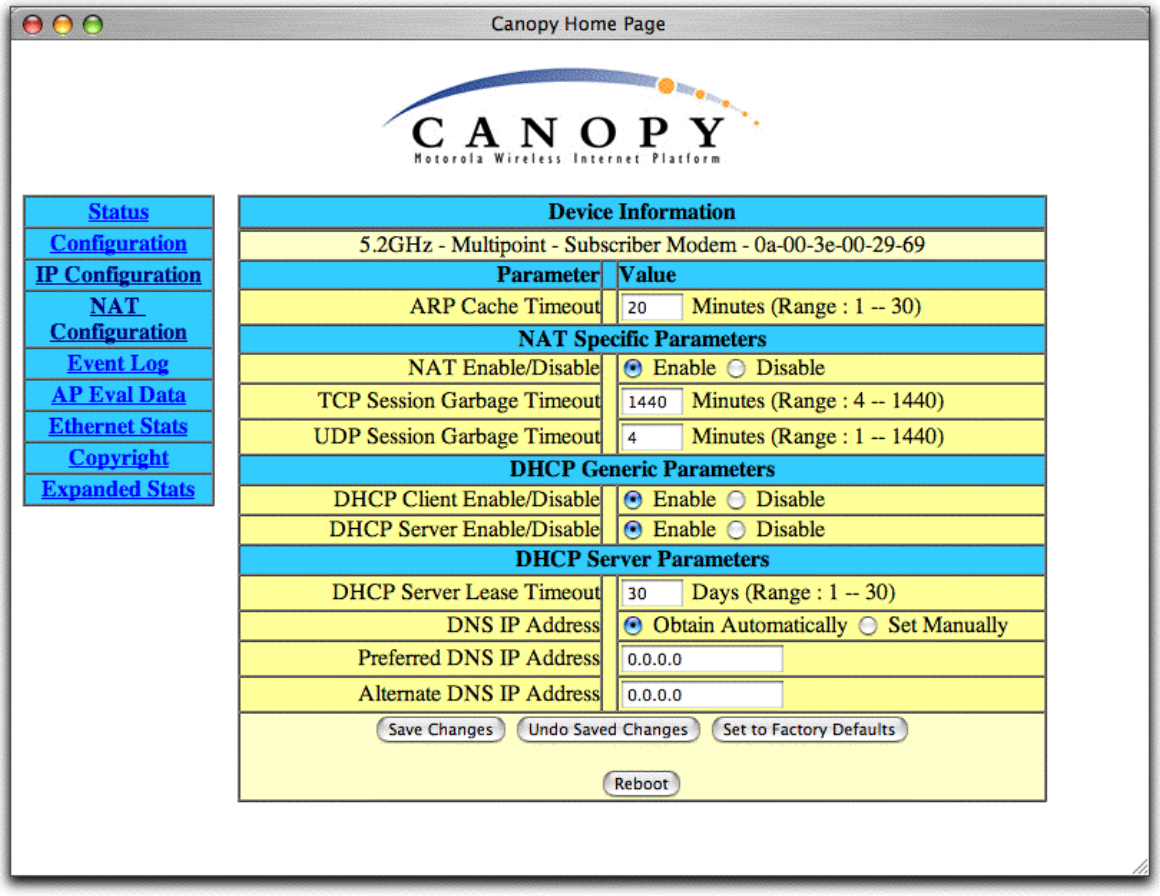


Figure 45: NAT Configuration screen, NAT with DHCP client and DHCP server

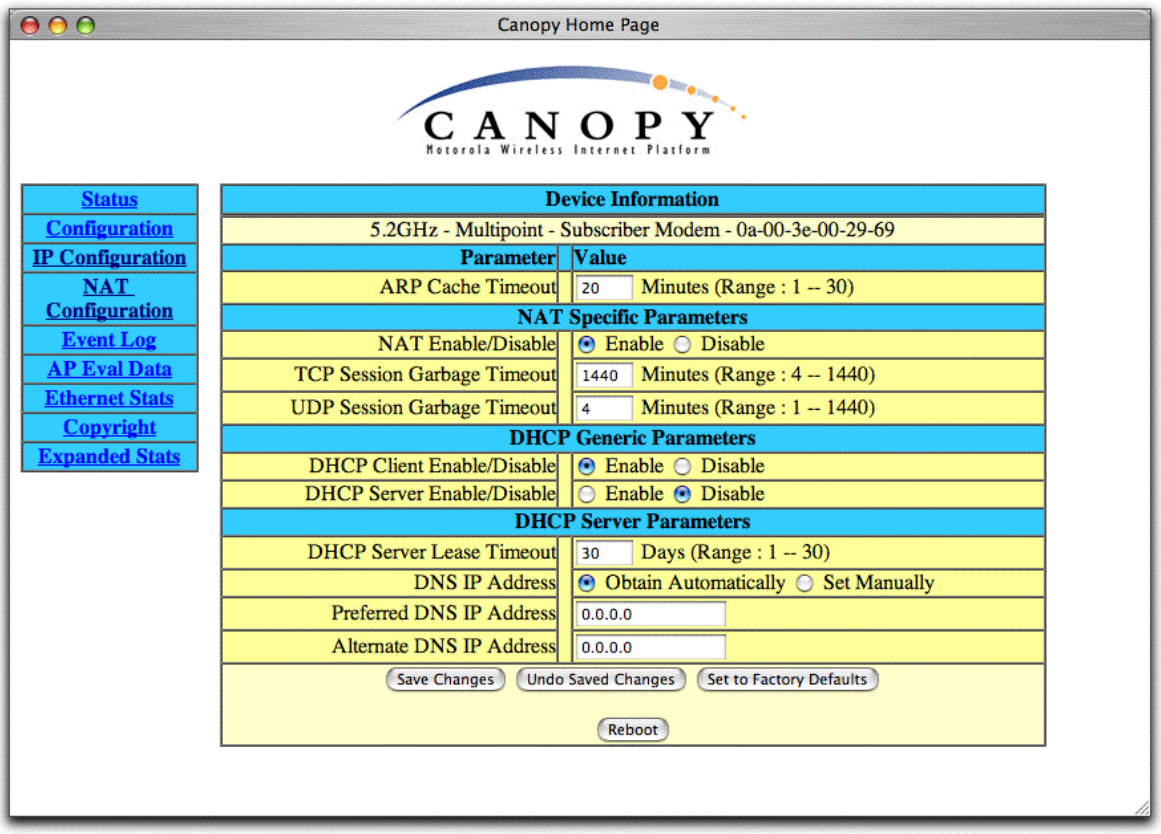


Figure 46: NAT Configuration screen, NAT with DHCP client

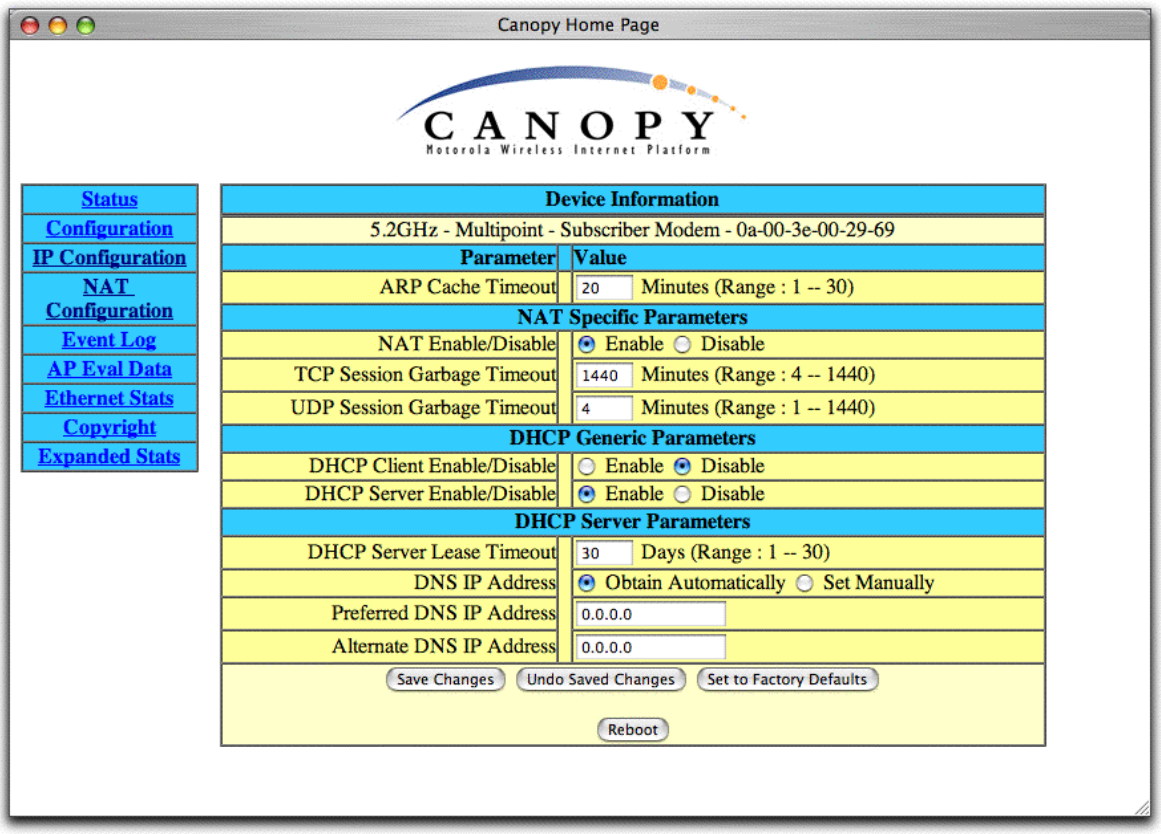


Figure 47: NAT Configuration screen, NAT with DHCP server

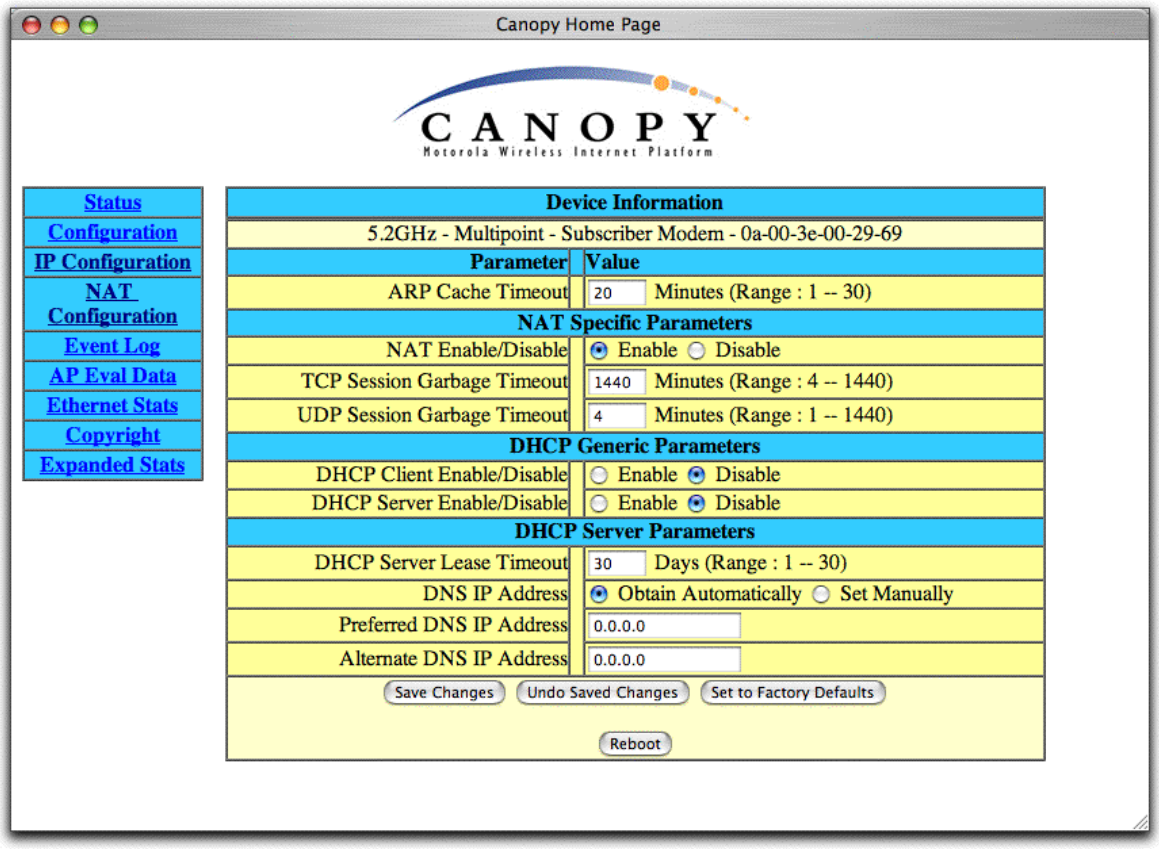


Figure 48: NAT Configuration screen, NAT without DHCP

ARP Cache Timeout

If a router upstream has an ARP cache of longer duration (as some use 30 minutes), then the operator enters a value of longer duration than the router ARP cache. The default value of this field is 20 seconds.

NAT Enable/Disable

The operator either disables NAT, or enables NAT to view additional options.

TCP Session Garbage Timeout

Where a large network exists behind the SM, the operator can set this value to lower than the default value of 1440 minutes (24 hours). This action makes additional resources available for greater traffic than the default value accommodates.

UDP Session Garbage Timeout

The operator may adjust this value in the range of 1 to 1440 minutes, based on network performance. The default value of this parameter is 4 minutes.

DHCP Client Enable/Disable

The operator selects either

- **Enable** to allow the network DHCP server to assign the NAT Public Network Interface Configuration IP address, subnet mask, and gateway IP address for this SM.
- **Disable** to
  - disable DHCP server assignment of this address.
  - enable the operator to assign this address.

DHCP Server Enable/Disable

The operator selects either

- **Enable** to
  - allow this SM to assign IP addresses, subnet masks, and gateway IP addresses to attached devices.
  - assign a start address for the SM.
  - designate how many IP addresses may be leased on the IP Configuration page of this SM.
- **Disable** to disallow the SM to assign addresses to attached devices.

DHCP Server Lease Timeout

The operator may adjust this value in the range of 1 to 30 days, based on network performance. The default value of this parameter is 30 days.

DNS IP Address

The operator selects either

- **Obtain Automatically** to allow the system to set the IP address of the DNS server.
- **Set Manually** to allow the operator to set both a preferred and an alternate DNS IP address.

Preferred DNS IP Address

If the **DNS IP Address** parameter is set to **Set Manually**, then the operator sets this parameter as the preferred address of the DNS server.

Alternate DNS IP Address

If the **DNS IP Address** parameter is set to **Set Manually**, then the operator sets this parameter as the alternate address of the DNS server.

8.4.4 NAT Configuration Buttons with NAT Enabled

Regardless of whether NAT is enabled, the NAT Configuration page provides the following buttons:

Save Changes

When the operator clicks this button, any changes that have been made on the NAT Configuration page are recorded in flash memory. However, these changes *do not* apply until the next reboot of the module.

Undo Saved Changes

When the operator clicks this button, any changes that have been made but were not committed by a reboot of the module are undone.

Set to Factory Defaults

When the operator clicks this button, all configurable parameters are reset to the factory settings.

Reboot

When the operator clicks this button, the module reboots. When the operator has changed parameters in the NAT Configuration page, the system highlights the **Reboot** button as a reminder that a reboot (in addition to a save operation) is required to implement the changes.

8.5 EVENT LOG PAGE

This page may contain information that can be useful under the guidance of Canopy technical support. For this reason, the operator *should not* clear the contents of this page before contacting technical support.

An example of the Event Log screen is displayed in Figure 49.

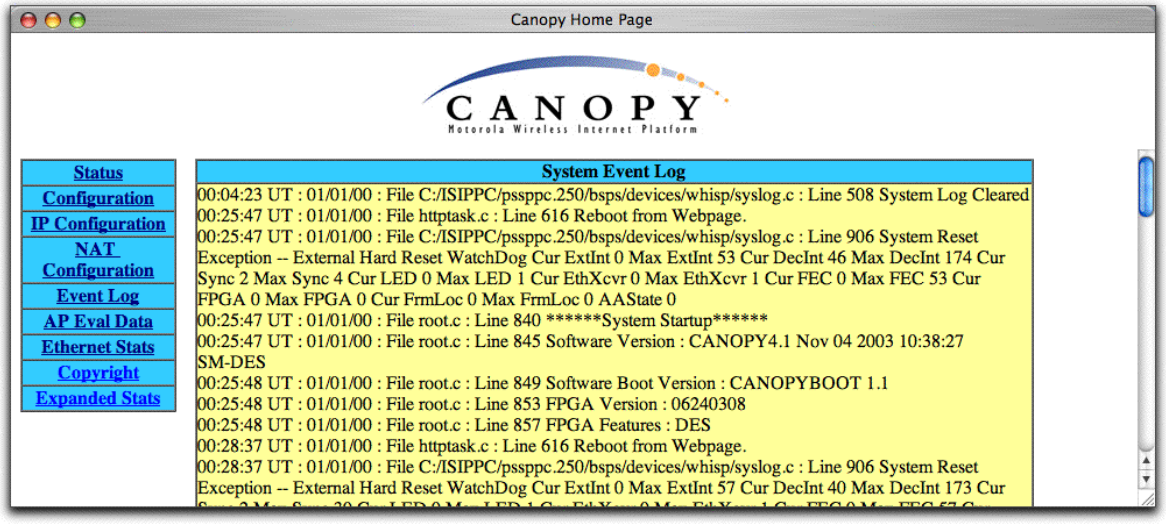


Figure 49: Event Log screen

8.5.1 Event Log Operator Option

The Event Log page provides only one button for the operator:

Clear Event Log

When the operator clicks this button, all of the Event Log page data is cleared.

8.6 AP EVAL DATA PAGE

The AP Eval Data web page provides information about the AP that the SM sees. An example of such information is shown in Figure 50.

> ***NOTE:*** In Release 4.0 and later releases, the data for this page can be suppressed by the **Disable Display of AP Eval Data** selection in the **SM Scan Privacy** field of the Configuration page on the AP.

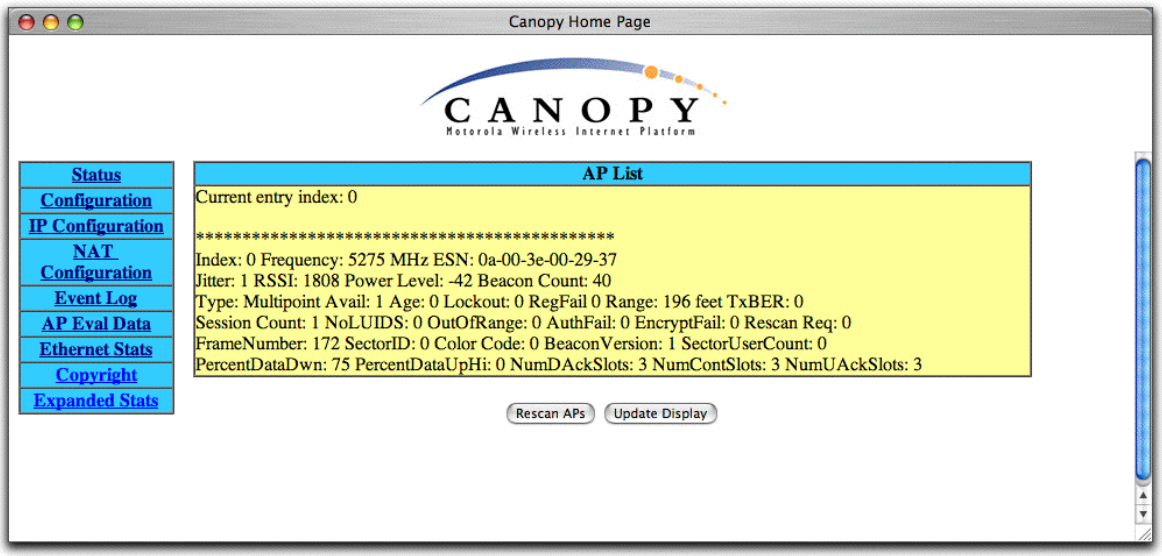


Figure 50: Example AP Eval Data page

8.6.1 AP Eval Data Parameters

The AP Eval Data page provides the following parameters that can be useful to manage and troubleshoot a Canopy system:

Index

This field displays the index value that the Canopy system assigns (for only this page) to the AP where this SM is registered.

Frequency

This field displays the frequency that the AP transmits.

ESN

This field displays the MAC address (electronic serial number) of the AP.

Jitter

This field displays the last jitter value that was captured between this SM and the AP.

Range

This field displays the distance in feet between this SM and the AP. To derive the distance in meters, the operator should multiply the value of this parameter by 0.3048.

Session Count

This field displays how many times this SM has gone into and out of session with the AP. If this number is particularly large, a problem may exist in the link (for example, improper line of sight or interference).

Sector ID

This field displays the value of the **Sector ID** field that is provisioned for the AP.

Color Code

This field displays the value of the **Color Code** field that is provisioned for the AP.

Sector User Count

This field displays how many SMs are registered on the AP.

Rescan APs

The operator can click this button to force the SM to rescan for the frequencies that are selected in the Configuration page. (See Custom RF Frequency Scan Selection List on Page 87.) This SM will then register to the AP that provides the best results for RSSI, Jitter, and number of registered SMs.

8.7 ETHERNET STATS PAGE

The Ethernet Stats web page reports TCP throughput and error information for the Ethernet connection of the SM.

8.7.1 Ethernet Stats Parameters

The Ethernet Stats page provides the following parameters:

inoctets count

This field displays how many octets were received on the interface, including those that deliver framing information.

inucastpkts count

This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.

innucastpkts count

This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.

indiscards count

This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. (Some of these packets may have been discarded to increase buffer space.)

inerrors count

This field displays how many inbound packets contained errors that prevented their delivery to a higher-layer protocol.

inunknownprotos count

This field displays how many inbound packets were discarded because of an unknown or unsupported protocol.

outoctets count

This field displays how many octets were transmitted out of the interface, including those that deliver framing information.

outucastpkts count

This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.

outnucastpkts count

This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.

outdiscards count

This field displays how many outbound packets were discarded without errors that would have prevented their transmission. (Some of these packets may have been discarded to increase buffer space.)

outerrrors count

This field displays how many outbound packets contained errors that prevented their transmission.

RxBabErr

This field displays how many receiver babble errors occurred.

EthBusErr

This field displays how many Ethernet bus errors occurred on the Ethernet controller.

CRCError

This field displays how many CRC errors occurred on the Ethernet controller.

RxOverrun

This field displays how many receiver overrun errors occurred on the Ethernet controller.

Late Collision

This field displays how many late collisions occurred on the Ethernet controller. A normal collision occurs during the first 512 bits of the frame transmission. A collision that occurs after the first 512 bits is considered a late collision.

A late collision is a serious network problem because the frame being transmitted is discarded. A late collision is most commonly caused by a mismatch between duplex configurations at the ends of a link segment.

RetransLimitExp

This field displays how many times the retransmit limit has expired.

TxUnderrun

This field displays how many transmission-underrun errors occurred on the Ethernet controller.

CarSenseLost
This field displays how many carrier sense lost errors occurred on the Ethernet controller.

8.8 EXPANDED STATS PAGE

The Expanded Stats web page provides statistics that the Canopy module collects. To facilitate troubleshooting, a Canopy technical support representative may ask the operator for specific information from this web page.

For the SM, the Expanded Stats page provides links to the following web pages:

- Link Capacity Test. See Link Test Page on Page 110.
- Alignment or Operational Mode statistics. See Alignment Page on Page 111.
- Receive BER Results. See BER Results Page on Page 113.
- Spectrum Analyzer (in Release 4.1 and later). See Spectrum Analysis on Page 59.

NOTE: A power cycle or reboot drops the contents of these pages.

8.9 LINK TEST PAGE

An example of the Link Capacity Test screen is displayed in Figure 51.

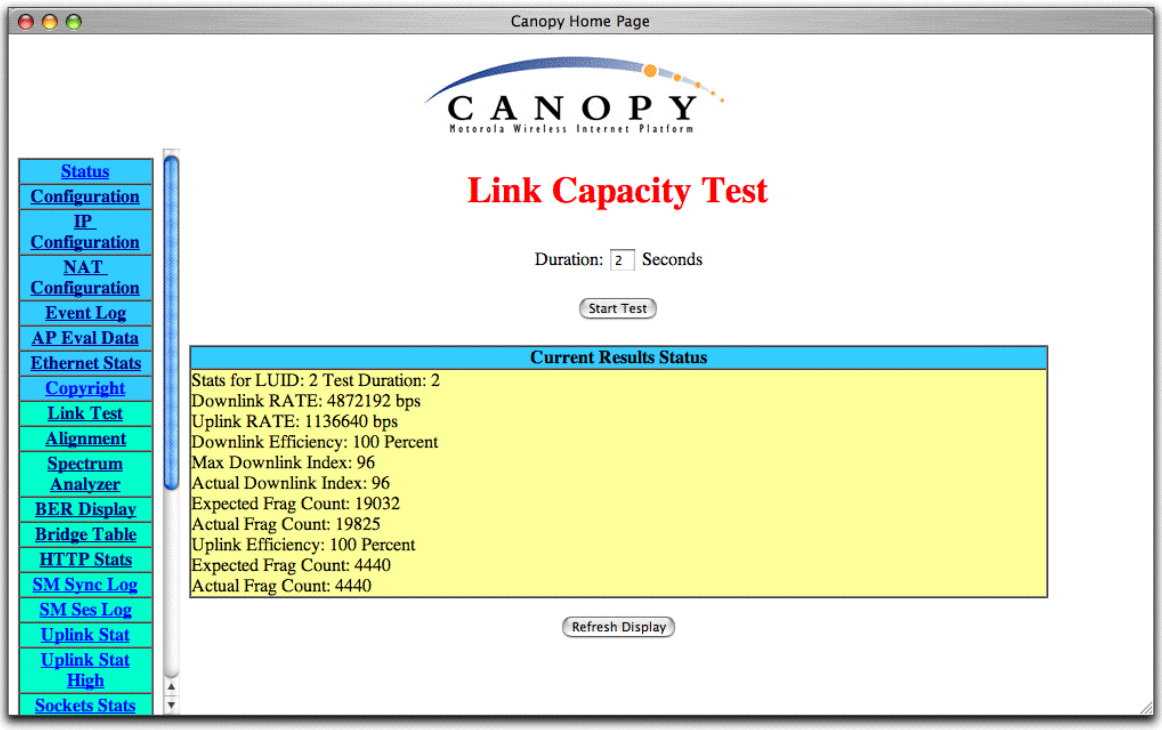


Figure 51: Link Test screen

The Link Capacity Test page allows the operator to measure the throughput and efficiency of the RF link between two Canopy modules. To test a link using this page, the operator

1. enters into the **Duration** field how long (in seconds) the RF link should be tested.
2. clicks the **Start Test** button.
3. clicks the **Refresh Display** button (if the web page is not set to automatically refresh).
4. views the results of the test.

8.9.1 Key Link Capacity Test Fields

The key fields in the test results are

- **Downlink RATE**, expressed in bits per second
- **Uplink RATE**, expressed in bits per second
- **Downlink Efficiency**, expressed as a percentage
- **Uplink Efficiency**, expressed as a percentage.

8.9.2 Capacity Criteria for the Link

A Canopy system link is acceptable only if the efficiencies of the link test are greater than 90% in both the uplink and downlink direction. It is recommended that when a new link is installed, a link test be executed to ensure that the efficiencies are within recommended guidelines.

8.10 ALIGNMENT PAGE

An example of the Alignment screen is displayed in Figure 52.

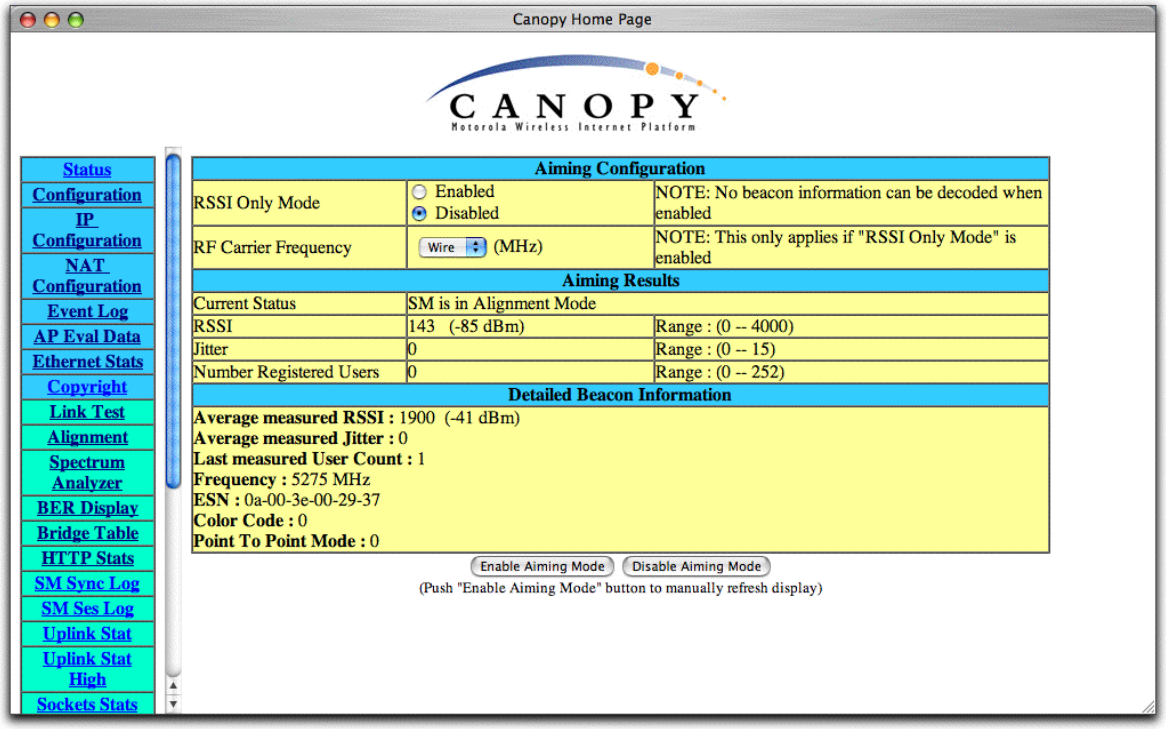


Figure 52: Alignment screen

8.10.1 SM Modes

The Alignment web page provides tools to assist in the alignment of an SM to an AP. Whether and how these tools operate depends on the mode that the operator invokes. The following modes are available:

- Normal Aiming Mode
- RSSI Only Aiming Mode
- Operating Mode

Regardless of the mode that the operator selects to align the module, all of the following indications are required for an acceptable link between the modules:

- RSSI greater than 700
- jitter value between 0 and 4 in Release 4.0 and later releases or between 5 and 9 in any earlier release
- uplink efficiency greater than 90%
- downlink efficiency greater than 90%

NOTE: If any of these values is not achieved, the SM may be operational but manifest occasional problems. In Release 4.0 and late releases, RSSI measurement is more consistent and jitter control is improved.

In either aiming mode, either the Alignment page must be set to automatically refresh or the operator must repeatedly click the **Enable Aiming Mode** button to keep current data displayed as the module is moved. After 15 minutes in an aiming mode, the module is automatically reset into the Operating Mode.

8.10.2 Normal Aiming Mode

In the Normal Aiming Mode

- the screen displays the RSSI level and the jitter value.
- the five left-most LEDs in the module act as a bar graph that indicates the best achieved RSSI level and jitter value when the greatest number of LEDs is lit. (The colors of the LEDs are not an indication in this mode.)

To invoke the Normal Aiming Mode, the operator

1. ensures that the **Disabled** button on the **RSSI Only Mode** line is checked.
2. clicks the **Enable Aiming Mode** button. (The aiming procedure is described on Page 79.)

8.10.3 RSSI Only Aiming Mode

In the RSSI Only Aiming Mode, the screen displays the signal strength based on the amount of energy in the selected frequency, regardless of whether the SM is registered to the AP. This mode simplifies the aiming process for long links, such as where the module is mounted to a Canopy Passive Reflector.

To invoke the RSSI Only Aiming Mode, the operator

1. selects the frequency of the AP in the Configuration Page of the SM. See Custom RF Frequency Scan Selection List on Page 87.
2. clicks the **Enable** button on the **RSSI Only Mode** line of the Alignment page.
3. clicks the **Enable Aiming Mode** button. (The aiming procedure is described on Page 79.)

8.11 SPECTRUM ANALYZER PAGE

An example of the Alignment screen is displayed in Figure 53.

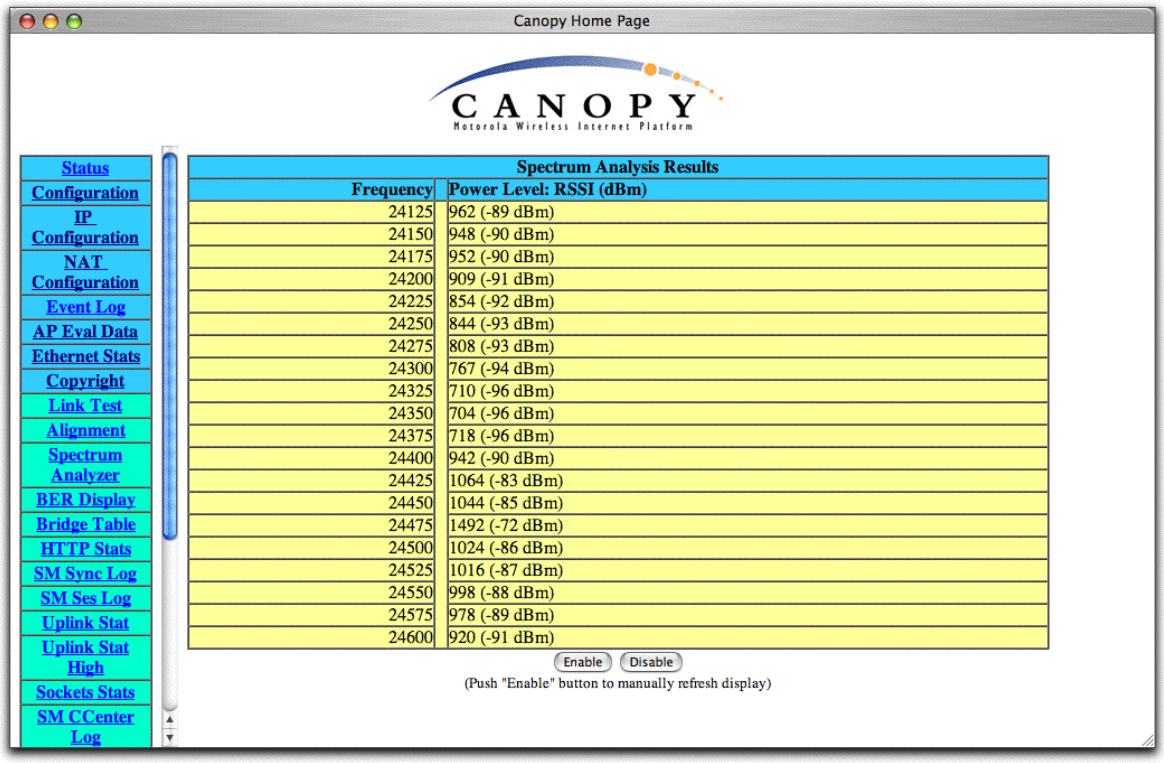


Figure 53: Spectrum Analyzer screen

The Spectrum Analyzer web page displays the power level in both RSSI and dBm units for each frequency that is analyzed. Either the Spectrum Analyzer page must be set to automatically refresh or the operator must repeatedly click the **Enable** button to keep current data displayed.

8.12 BER RESULTS PAGE

An example of the BER Results screen is displayed in Figure 54.

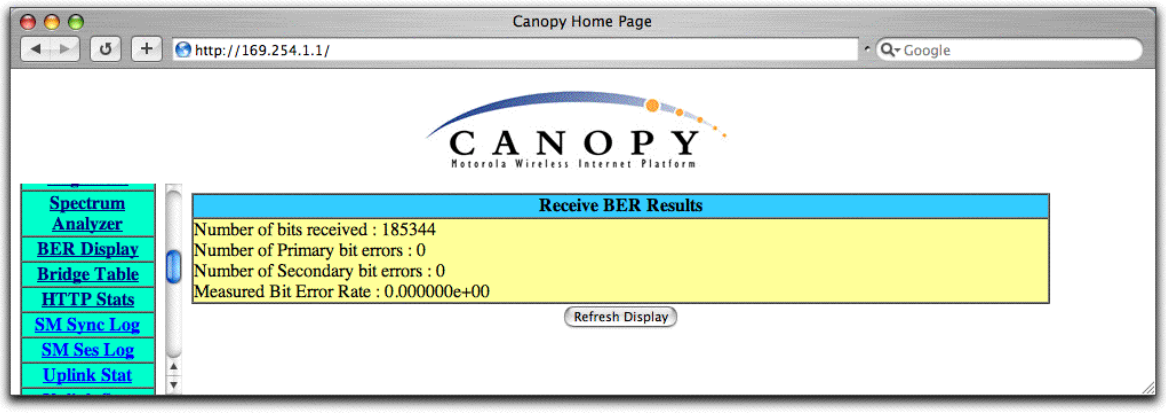


Figure 54: BER Results screen

8.12.1 BER Display

This page displays the current bit error rate in the link between the SM and the AP, but only when the AP is configured to send the BER stream.

The value in the **Measured Bit Error Rate** field represents the BER at the moment of the last browser refresh. To keep the value of this field current, the operator should either repeatedly click the **Refresh Display** button or set the screen to automatically refresh.

8.12.2 BER Results

The link is acceptable if the value of this field is less than 10^{-4}. If the BER is greater than 10^{-4}, then the operator must re-evaluate the installation of both modules in the link.

8.13 BRIDGE TABLE PAGE

An example of the Bridge Table screen is displayed in Figure 55.

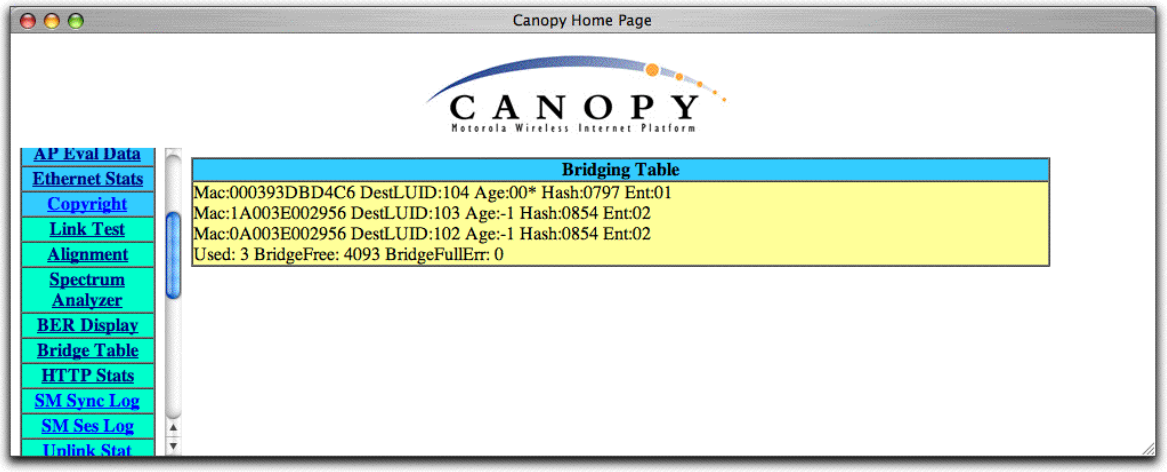


Figure 55: Bridge Table screen

The Bridge Table page identifies by MAC address and LUID the modules to which this SM serves as a Layer 2 bridge.

9 CANOPY SYSTEM ACCESSORIES

The following accessories are available to use with the Canopy system. To purchase accessories, contact an authorized Canopy dealer unless otherwise noted.

- Universal mounting bracket
- Passive reflector dishes
- 102 − 132 VAC power supply with North American plug (Part Number ACPS110)
- 100 − 240 VAC power supply with North American, UK, and Euro plugs (Part Number ACPSSW-02)
- Alignment Tool Headset (Part Number ACATHS-01)
- Cable assemblies for the Canopy system. These can be ordered from Best-Tronics Manufacturing, Inc. at http://www.best-tronics.com/motorola.

> ***NOTE:*** For the RF environment in which Canopy Backhaul, Access Point, and CMMs often operate, the use of shielded cable is *strongly* recommended for infrastructure cables that connect these modules.

10 SM MODULE SPECIFICATIONS

Table 13 provides the specifications of the Canopy SM.

Table 13: Specifications

Specification	Canopy System Range
Frequency Band Ranges	ISM: 2.4 to 2.4835 GHz U-NII: 5.25 to 5.35 GHz and 5.725 to 5.825 GHz ISM in Release 4.0 and later: 5.725 to 5.850 GHz
Access Method	TDD/TDMA
Signaling Rate	10 Mbps
Maximum Aggregate Throughput for 2.4-, 5.2-, and 5.7-GHz SMs	Downlink: 4.6 Mbps at default allocation of 75%, but variable based on packet size. Uplink: 1.6 Mbps at default allocation of 25%, but variable based on packet size.
Modulation Type	High-index 2-level FSK (Frequency Shift Keying) (Optimized for interference rejection)
Carrier to Interference (C/I)	3 dB nominal
Receiver Sensitivity	−83 dBm at 10^{-4} BER
Operating Range	Up to 2 miles (3.2 km) with integrated antenna in the 5.2-GHz and 5.7-GHz bands. Up to 5 miles (8 km) with integrated antenna in the 2.4-GHz band. Up to 10 miles (16 km) with passive reflector on the SM in the 5.7-GHz band. Up to 15 miles (24 km) with passive reflector on the SM in the 2.4-GHz band.
Transmitter Power	Meets FCC U-NII/ISM and IC LELAN ERP Limit.
Antenna	Integrated patch. Vertically polarized. In 2.4-GHz band with passive reflector: 17° horizontal x 17° vertical beam width. In 5.2-GHz band and 5.7-GHz band without passive reflector: 60° horizontal x 60° vertical beam width. In 5.7-GHz band with passive reflector: 6° horizontal x 6° vertical beam width.
DC Power (measured at DC converter)	0.3 A @ 24 VDC (7.2 watts) typical. 0.35 A @ 24 VDC (8.4 watts) maximum (long cable runs, high ambient temperature, high transmit ratio). Set by downlink percentage.

Specification	Canopy System Range
Ethernet, GPS sync, and GPS coax cables	The use of cables that are rated for the operation temperature of the product and that conform to UV light protection specifications is mandatory. The use of shielded cables is strongly recommended. For information about the supplier of these cables, see CANOPY SYSTEM ACCESSORIES on Page 116.
Interface	10/100BaseT, half/full duplex. Rate auto-negotiated (802.3 compliant).
Protocols Used	IPv4, UDP, TCP, ICMP, Telnet, HTTP, FTP, SNMP, DES. Optionally, AES.
Protocols Supported	Switched Layer 2 Transport with support for all common Ethernet protocols, such as IPv6, NetBIOS, DHCP, IPX.
Software Upgrade Path	Remotely downloaded into flash memory
Network Management	HTTP, telnet, FTP, SNMP
Wind	118 miles/hour (190 km/hour)
Operation Temperature	−40° F to +131° F (−40° C to +55° C)
Weight	1 lb (0.45 kg) without passive reflector.
Reflector Dish Weight	6.5 lb (2.9 kg) with assembly, without module
Dimensions	11.75” H x 3.4” W x 3.4” D (29.9 cm H x 8.6 cm W x 8.6 cm D)
Reflector Dish Dimensions	18” H x 24” W (45.7 cm H x 61.0 cm W)
Mean Time Between Failure (MTBF)	40 years
Mean Time to Repair	15 minutes

11 HISTORY OF CHANGES IN THIS DOCUMENT

Issue 4 introduced the following changes:

- Information that supports Release 4.1 features
- Information that supports 2.4-GHz modules

Issue 3 introduced the following changes:

- AES (Advanced Encryption Standard) security product description
- 5.7-GHz ISM support of 6 channels (increased from 4 with 5.7-GHz U-NII)
- 5.7-GHz ISM frequencies approved for use in Canada as in the U.S.A.
- List of MAC (Media Access Control) addresses for older modules that *do not* automatically sense the cabling scheme (These modules require the installer to correctly choose whether to use straight-thru or crossover cables.)

Issue 2 introduced the following changes:

- Updates in the Notices section for
  - European Community Notification.
  - RF Exposure.
  - software license terms and conditions.
- Internationalization of measurement units to provide metric units aside the English units
- Updates for new hardware features, to reflect that modules that are shipped from the publication date forward
  - auto-sense the Ethernet termination (Either a straight-thru or crossover RJ-45 cable can be used to connect to either a network interface card or a hub, switch, or router.)
  - include additional cable openings to facilitate shielded cable installation.
- Changes in specifications to reflect the expanded lower temperature limit (-40°F/-40°C) for all equipment